

NASA SP-7037 (273)

January 1992



RONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



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AERONAUTICAL ENGINEERING

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National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1992

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 808 reports, journal articles, and other documents originally announced in December 1991 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA)*.

Accession numbers cited in this issue are:

STAR (N-10000 Series) N91-31078 — N91-33053
IAA (A-10000 Series) A91-52999 — A91-57068

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1991 will be published in early 1992.

Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

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TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED
ON MICROFICHE

ACCESSION NUMBER → N91-10010*# Institute for Computer Applications in Science and Engineering, Hampton, VA. ← CORPORATE SOURCE

TITLE → **TURBULENT FLOW CALCULATIONS USING UNSTRUCTURED AND ADAPTIVE MESHES Final Report** ← PUBLICATION DATE

AUTHOR → DIMITRI J. MAVRIPLIS Sep. 1990 32 p Submitted for publication

CONTRACT NUMBER → (Contract NAS1-18605)

REPORT NUMBERS → (NASA-CR-182102; NAS 1.26:182102; ICASE-90-61) Avail: NTIS ← AVAILABILITY SOURCE

PRICE CODE → HC/MF A03 CSCL 01A ← COSATI CODE

A method of efficiently computing turbulent compressible flow over complex two dimensional configurations is presented. The method makes use of fully unstructured meshes throughout the entire flow-field, thus enabling the treatment of arbitrarily complex geometries and the use of adaptive meshing techniques throughout both viscous and inviscid regions of flow-field. Mesh generation is based on a locally mapped Delaunay technique in order to generate unstructured meshes with highly-stretched elements in the viscous regions. The flow equations are discretized using a finite element Navier-Stokes solver, and rapid convergence to steady-state is achieved using an unstructured multigrid algorithm. Turbulence modeling is performed using an inexpensive algebraic model, implemented for use on unstructured and adaptive meshes. Compressible turbulent flow solutions about multiple-element airfoil geometries are computed and compared with experimental data. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED
ON MICROFICHE

ACCESSION NUMBER → A91-11198*# Oklahoma State Univ., Stillwater. ← CORPORATE SOURCE

TITLE → **FLOW AND ACOUSTIC PROPERTIES OF LOW REYNOLDS NUMBER UNDEREXPANDED SUPERSONIC JETS**

AUTHORS → TIEH-FENG HU and D. K. MCLAUGHLIN (Oklahoma State University, Stillwater) Journal of Sound and Vibration (ISSN 0022-460X), vol. 141, Sept. 22, 1990, p. 485-505. refs ← AUTHORS' AFFILIATION

CONTRACT NUMBERS → (Contract NAG1-10; NAG1-159) Copyright ← JOURNAL TITLE

An experimental program to investigate the flow and acoustic properties of model underexpanded supersonic jets was conducted. In particular, the role played by large-scale organized fluctuations in the flow evolution and acoustic production processes was examined in detail. The experimental conditions were chosen as low-Reynolds-number ($Re = 8000$) Mach 1.4 and 2.1 underexpanded jets exhausting from convergent nozzles. A consequence of performing the experiments at low Reynolds number is that the broad and shock-associated noise is suppressed. The focus of the present study is on the generation of noise by large-scale instabilities in the presence of strong shock cell structures. It is demonstrated that the production of screech is related to the modulation and decay of large-scale turbulence structures. Author

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JANUARY 1992

01

AERONAUTICS (GENERAL)

A91-53003

FAST - FUNCTIONAL AVIONICS SYSTEM TESTER

WILLIAM A. BOSTROM and HENRY J. BALUTA (Grumman Corp., Bethpage, NY) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 7-12. refs
Copyright

A description is given of the Functional Avionics System Tester (FAST), which is structured to test weapon replaceable assemblies (WRA) functionally and to make greater use of the WRA built-in-test hardware and software. FAST will be used to test certain WRAs that are part of the avionics upgrade from the F-14D fighter. It will be used in a depot environment until the Consolidated Automated Support System is operational. FAST has a small physical footprint (4-ft wide by 3-ft deep), achieved primarily by its instruments-on-a-board design approach. The FAST test station is described in detail, and block diagrams are provided. I.E.

A91-53025

A FLEXIBLE, MATE COMPLIANT PORTABLE TEST SET

SERGIO PARISE (Allied-Signal Aerospace Co., Bendix Test Systems Div., Teterboro, NJ) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 195-198. refs
Copyright

A MATE compliant portable test unit that is based on the VME and VXI system architectures is presented. This stand alone test set (SATS) is the central computer of the Bendix developed avionics test system for the A-7 Corsair. It has been designed with the flexibility to allow application-specific configurations. The incorporation of artificial-intelligence diagnostics and the ability to present online technical documentation enhances the SATS' ability to operate in future test scenarios. I.E.

A91-53037

VXI BASED MICROWAVE TESTING ON THE FLIGHTLINE

ROBERT J. BOWES and JOHN R. SCOGGINS (Lockheed Sanders, Inc., Defense Systems Div., Nashua, NH) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 309-314.
Copyright

It has been demonstrated that modification of standard commercial VXI instruments to meet the environmental extremes of the flight line provides an affordable VXI-based microwave tester to accurately determine system performance levels and aids in the integration of aircraft suites. The VXIbus provides the test control environment of triggers and synchronization necessary for systems-level testing of installed aircraft systems. This tester can

take advantage of commercial components for all but the most stringent environmental considerations and can also handle rapid configuration changes by using commercial modules for prototyping. A prototype VXIbus-based microwave tester that is operational and undergoing evaluation testing is examined. I.E.

A91-53055

SECOND GENERATION JET ENGINE DIAGNOSTIC COMPUTER FOR FLIGHT LINE MAINTENANCE APPLICATIONS

DENNIS DAUBEN (Science Applications International Corp., San Diego, CA) and ELIDA TIREY (Pratt and Whitney Group, West Palm Beach, FL) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 559-565.
Copyright

The features of the SAIT 1184 computer, which is the heart of the Comprehensive Engine Diagnostic System (CED), are described. Operation of the CED System 1184 computer is menu-driven to prompt the user from one function to another. A single-point connection on the engine permits retrieval and display of stored Engine Diagnostic Unit data and fault codes. A second single point connection near the Digital Electronic Engine Control (DEEC) is used to retrieve DEEC fault data and display real-time digital data. The CED computer can operate on a 24-V battery or can use 115V AC 50 -400 Hz (with a converter) from a flight-line power cart or other available sources to power itself and the Engine Diagnostic Unit. The CED computer will be used on the flight line as well as in test cell environments. The following features are discussed in detail: power consumption and processing power, application memory, and expansion boards. I.E.

A91-53056

ENGINE MONITORING SYSTEM DIAGNOSTICS FOR THE TF30-P111 ENGINE

RICHARD D. SOMERS (Southwest Research Institute, San Antonio, TX) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 567-573.
(Contract F04606-87-D-0056)
Copyright

The development of an engine monitoring system (EMS) for the TF30, a high-bypass afterburning turbofan engine, is reviewed. EMS features providing flight-line diagnostics and improved maintenance troubleshooting capability are described. System design incorporates standard components and technology insertion upgrades such as an MIL-STD-1750A computer. A level-three design package was produced and delivered to the Air Force to be used for competitive procurement of components from multiple sources. I.E.

A91-53195

UNMANNED SYSTEMS WIN UNEXPECTED SUPPORT

RON SCHNEIDERMAN *Microwaves & RF* (ISSN 0745-2993), vol. 30, Sept. 1991, p. 34, 35, 37, 39, 43.
Copyright

A review of unmanned aerial vehicles (UAVs) is presented in which emphasis is given to recent mission accomplishments and

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current directions of research. Existing and new military UAV programs are listed with reference to funding, the type of vehicle, and level of development. Several trends are established including the reliance of UAVs on global positioning satellites and advanced electronics and the growth of the UVA industry. UAVs that are in advanced stages of development or have been deployed include short-range UAV such as the Pioneer, the Pointer, the Sky Owl, and the Hunter. Key UAV systems are described such as the Advanced Tactical Airborne Reconnaissance System, the Maritime Vertical Takeoff and Landing, and other VTOL systems. Very small UAVs and Exdrones are also discussed, and a weather reconnaissance system and surveillance systems are mentioned.

C.C.S.

A91-53855#

APPLIED AERODYNAMICS LITERACY - WHAT IS IT NOW? WHAT SHOULD IT BE?

W. H. MASON (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs (AIAA PAPER 91-3313) Copyright

Applied aerodynamics encompasses a broad area of aerospace engineering. A discussion of the issues shaping the requirements for competence in applied aerodynamics is presented. To gain insight into contemporary attitudes a survey of the AIAA Applied Aerodynamics TC members was made, and the results are discussed. Similarly, an examination of the aerospace courses offered by thirty aerospace engineering departments was made to gain insight into applied aerodynamics programs in the academic community. An analysis of the issues, TC member attitudes, and educational programs is then used to propose a basis for literacy in applied aerodynamics. Some specific actions that can be taken to ensure that an adequate level of literacy is maintained are given.

Author

A91-53926

AIR TRANSPORT RESEARCH IN GERMANY [LUFTFAHRTFORSCHUNG IN DEUTSCHLAND]

HEINZ MAX (DLR, Cologne, Federal Republic of Germany) Luft- und Raumfahrt (ISSN 0173-6264), vol. 12, July-Aug. 1991, p. 12, 13, 16, 17, 19. In German.

Copyright

The Senate of the DLR is considering an intermediate term research program for air transport covering the period 1991-1995. This paper describes the proposed air transport research goals and program structure.

C.D.

A91-53927

GERMAN-ITALIAN COOPERATION [KOOPERATION DEUTSCHLAND-ITALIEN]

ANTONIO O. CIAMPI Luft- und Raumfahrt (ISSN 0173-6264), vol. 12, July-Aug. 1991, p. 20-22, 24, 26, 28, 29. In German.

Copyright

Coooperative efforts by the German and Italian aerospace industries are discussed. Programs involving the development of the European Fighter Aircraft, regional civil aircraft and training aircraft, the AAA amphibious aircraft project, transport aircraft, and helicopters are addressed. Attention is given to joint programs to develop military and civil engines and to space technology programs.

C.D.

A91-53928

AIRBUS A321 - FINAL SPURT TO THE FINISH LINE [AIRBUS A321 - ENDSPIRT AUF DIE ENDLINIE]

GUSTAV HUMBERT (Deutsche Airbus GmbH, Hamburg, Federal Republic of Germany) Luft- und Raumfahrt (ISSN 0173-6264), vol. 12, July-Aug. 1991, p. 30-33. In German.

Copyright

The final stages of work leading up to the first flight of an Airbus A321, set for March 1993, are discussed. Emphasis is given to the final stages of construction and assembly of the aircraft. The improvements over the A320 embodied in the final aircraft are addressed.

C.D.

A91-53929

GERMAN AIRPORTS - CAPACITY CRISIS [DEUTSCHE FLUGHAEFEN - KAPAZITAETSKRISE]

Luft- und Raumfahrt (ISSN 0173-6264), vol. 12, July-Aug. 1991, p. 34-37. In German.

Copyright

A report on the crisis of German airports is discussed. The importance of airports to the German economy is addressed, and the aircraft noise problem is examined. Solutions are considered, including the development of quieter aircraft, improved planning with regard to the use of space for airports, and reducing emissions at airports.

C.D.

A91-54008#

LIGHT HELICOPTER/COMANCHE PROGRAM UPDATE - THE LHTEC T800 AND BOEING SIKORSKY COMANCHE DESIGN SOLUTIONS

ROBERT HUBBARD (U.S. Army, Washington, DC), JIM MORRIS (Boeing Co., Seattle, WA; Sikorsky Aircraft, Stratford, CT), and RONALD ALTO (Light Helicopter Turbine Engine Co., Saint Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. (AIAA PAPER 91-3074)

Important technologies incorporated into the LHTEC T800 engine and the winning Boeing Sikorsky Comanche weapon system designs are addressed in detail. Both LHTEC and the Boeing Sikorsky team are taking advantage of advanced technologies, in conjunction with MANPRINT, total quality management, and concurrent engineering principles, to significantly improve producibility and supportability. This balanced approach of incorporating advanced technologies is considered to provide a quantum improvement in Comanche war fighting effectiveness, as compared with existing Army helicopter alternatives.

O.G.

A91-54009#

V-22 VARIANTS - JOINT SERVICE FORCE MULTIPLIERS

ROSS CLARK (Boeing Co., Bell-Boeing Joint Program Office, Philadelphia, PA) and WILLIAM A. BATTEY (Boeing Co., Helicopters Div., Philadelphia, PA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p.

(AIAA PAPER 91-3077) Copyright

An evaluation is made of the performance advantages accruing to the V-22 tilt-rotor VTOL in the operational contexts of the four U.S. Armed Services, and in expeditionary missions where the reduction of aircraft-type inventories is a critical logistical consideration. Pallet-kits have been developed through whose incorporation the V-22 can undertake EW, C3I, AEW, ASW, aerial refueling, and direct air support. Attention is given to the V-22's unique airborne refueling tanker capabilities, which extend to the onloading of fuel from a ship or other stationary or semistationary platform while hovering.

O.C.

A91-54019#

FLIGHTDECK-ATC INTEGRATION - HUMAN FACTOR'S GREATEST CHALLENGE FOR THE 21ST CENTURY

J. R. SWINK (Douglas Aircraft Co., Long Beach, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 5 p. refs

(AIAA PAPER 91-3090) Copyright

Consideration is given to the National Airspace System, which is argued to be the busiest, safest, and most efficient system in the world. Particular attention is given to the role of the human operator in future automated systems.

O.G.

A91-54025*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

OVERVIEW OF AIRFRAME TECHNOLOGY IN THE NASA HIGH-SPEED RESEARCH PROGRAM

ALLEN H. WHITEHEAD, JR. (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 32 p.

refs

(AIAA PAPER 91-3100) Copyright

NASA's Phase I High-Speed Research Program has been established to develop solutions for critical environmental issues confronting the next-generation U.S. SST, or High-Speed Civil Transport (HSCT). Attention is presently given to the ways in which HSCT environmental acceptability is affected by such airframe-technology features as laminar flow control, advanced high-lift systems for TO&L, and contour tailoring for sonic-boom minimization. The reduction of sonic booms is economically critical to the HSCT, in that it will permit overland flight at supersonic speeds and therefore maximize the reduction in long-range flight times. O.C.

A91-54055#

AIRCRAFT WIRING DAMAGE - DEVELOPMENT OF A COMPUTERIZED ASSESSOR AID

MATHIAS L. KOLLECK and KARL F. SEIBERT (Booz, Allen and Hamilton, Inc., Dayton, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 6 p. refs
(AIAA PAPER 91-3137) Copyright

The electrical wiring systems of modern aircraft are extremely complex and, therefore, very difficult to assess and repair quickly. These difficulties will only increase as more sophisticated aircraft are fielded with advanced technologies providing increased capabilities, which in turn will increase the number of wires required. A computerized assessor aid will provide important benefits in dealing with this problem: significant reductions in diagnostic/repair times and in skill level requirements. Author

A91-54057#

AIRCRAFT COMBAT SURVIVABILITY - AN INTRODUCTION TO THE FUNDAMENTALS OF SURVIVABILITY ENGINEERING

NIKOLAOS CARAVASOS (Boeing Helicopters, Philadelphia, PA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p.
(AIAA PAPER 91-3141) Copyright

The aircraft combat survivability (ACS) design discipline entails not only a thorough understanding of the aircraft as a totality, and of the vulnerabilities of its critical systems, but also of the nature of both current and anticipated potential threats. A comprehensive introduction is presented for ACS analyses, encompassing aircraft, missile, artillery, nuclear blast, and laser threats. Flowcharts of the threat/vulnerability-consideration processes are presented, and attention is given to the unique survivability problems posed by such novel materials as primary-structure composites. O.C.

A91-54065#

THE INTEGRATED DESIGN AND MANUFACTURING APPROACH TO THE X-31A

SIDNEY A. POWERS (Rockwell International Corp., El Segundo, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 13 p. refs
(AIAA PAPER 91-3150) Copyright

The basis of the rapid development pace achieved for the X-31 Enhanced Fighter Maneuverability demonstrator aircraft was the formation of an engineering-and-manufacturing team which encompassed employees from the U.S. and West German firms involved in the effort. Tooling-related innovations produced by this team are estimated to have reduced tooling costs by 80 percent. Quality control was embedded in the manufacturing process by assigning greater responsibility to production-line assembly personnel. Attention was given to the application of composite materials to primary airframe structures. O.C.

A91-54397

SOME EXPERIENCES OF ADVANCED MANUFACTURING CELLS AT BRITISH AEROSPACE WARTON UNIT

J. M. DUXBURY (British Aerospace /Military Aircraft/, Ltd., Preston, England) Institution of Mechanical Engineers, Proceedings, Part

G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 205, no. G1, 1991, p. 59-63.

Copyright

The problem of makespan reduction is examined with reference to the manufacturing experience of British Aerospace Warton Unit. In particular, three production facilities are described which use three different approaches to achieve significant makespan reductions: automation between processes, organizational change, and 'automation of the shell' where conventional techniques are complemented by automated logistics. V.L.

A91-55031

THREE DECADES OF AERONAUTICAL RESEARCH AT ADE

K. G. NARAYANAN (Aeronautical Development Establishment, Bangalore, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, Feb. 1991, p. 1-4.

The evolution of the Aeronautical Development Establishment (ADE), a major Indian organization for aeronautical research and development is described together with the current ADE programs. Special attention is given to a program for the development of a pilotless target aircraft which will enter service with the Army, Navy, and Air Force in 1992-1993 as a target system for surface-to-air and air-to-air missiles and guns, and the program for the development of the Light Combat Aircraft which will incorporate a reliable digital fly-by-wire flight control system. Future programs will center on the use of computational techniques in the analysis of flow, the development of new structural materials with tailored properties, the use of 'smart' structural elements for adaptive behavior in flight, the active control technology, the use of knowledge-based systems in aircraft for flight management, and technology for the direct voice input in the cockpit. I.S.

A91-55424

MONITORING AND DIAGNOSIS OF CIVIL AVIATION EQUIPMENT [KONTROL' I DIAGNOSTIROVANIE GRAZHDANSKOI AVIATSIONNOI TEKHNIKI]

VADIM I. IAMPOL'SKII, NIKOLAI I. BELOKON', and BORIS N. PILIPOSIAN Moscow, Izdatel'stvo Transport, 1990, 184 p. In Russian. refs
Copyright

Problems associated with the monitoring and diagnosis of civil aviation equipment are examined. In particular, attention is given to the specific features of the monitoring of technical condition and performance of powerplants and hydromechanical systems. The discussion covers the development of diagnostic algorithms and mathematical models, automated monitoring of aircraft systems in flight, evaluation of the general technical condition of aviation equipment in the process of maintenance and repair work, and organizational and information aspects of diagnosis. V.L.

A91-56121 National Aeronautics and Space Administration, Washington, DC.

ATMOSPHERIC EFFECTS OF STRATOSPHERIC AIRCRAFT - A STATUS REPORT FROM NASA'S HIGH-SPEED RESEARCH PROGRAM

HOWARD L. WESOKY (NASA, Washington, DC) and MICHAEL J. PRATHER (NASA, Goddard Institute for Space Studies, New York) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 211-220. refs
Copyright

Studies have indicated that, with sufficient technology development, future high-speed civil transport aircraft could be economically competitive with long-haul subsonic aircraft. However, uncertainty about atmospheric pollution, along with community noise and sonic boom, continues to be a major concern which is being addressed in the planned six-year High-Speed Research Program begun in 1990. Building on NASA's research in atmospheric science and emissions reduction, current analytical predictions indicate that an operating range may exist at altitudes below 20 km (i.e., corresponding to a cruise Mach number of approximately 2.4) where the goal level of 5 gm equivalent NO₂

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emissions/kg fuel will deplete less than one percent of column ozone. Because it will not be possible to directly measure the impact of an aircraft fleet on the atmosphere, the only means of assessment will be prediction. The process of establishing credibility for the predicted effects will likely be complex and involve continued model development and testing against climatological patterns. In particular, laboratory simulation of heterogeneous chemistry and other effects, and direct measurements of well understood tracers in the troposphere and stratosphere are being used to improve the current models. Author

A91-56250

EUROPEAN COLLABORATION - A CHANGING SCENE IN AERO-ENGINE RESEARCH

R. J. DUNKER (CEC, Directorate General for Science, Research and Development, Brussels, Belgium) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 7 p.

Copyright

A review is presented of the action taken to secure a technology base in aeronautics for Europe by implementing a two year exploratory research program. Attention is focused on propulsion related projects concerning boundary layer transition prediction on turbine blades, secondary flow effects in turbomachines, development of sensors for aeroengine application and the problems of low emission combustor technology. Consideration is given to the study of transition in turbomachinery flows, the transonic turbine wake mixing process, and bearings with minimum lubrication. R.E.P.

A91-56375

AN ENGINEER'S PERSPECTIVE ON THE AIR TRANSPORTATION INDUSTRY - THE LAST FORTY YEARS (THE SEVENTEENTH WILLIAM LITTLEWOOD MEMORIAL LECTURE)

JOSEPH F. SUTTER (Boeing Commercial Airplane Group, Seattle, WA) and DAVID C. KNOWLEN (Boeing Co., Seattle, WA) William Littlewood Memorial Lectures, 17th, Long Beach, CA, Oct. 1-4, 1990. 19 p.

(SAE PAPER 902012; SAE SP-845) Copyright

A biographical sketch is presented tracing the career of Joseph Sutter as a designer of some of the most successful commercial jet transports built by Boeing. His experience as an aerodynamicist ranges from the piston engine powered Stratocruiser to the jet powered 707, 727, 747, 737, and lastly the 757 and 767 transports. Lessons are drawn on aircraft design, business philosophy, and the role of the engineer. R.E.P.

A91-56750

F-22 - MANAGING THE CHALLENGE

GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 140, Sept. 25, 1991, p. 32-34.

Copyright

An overview is presented of the management concepts and evolutionary design and development improvements that are being implemented for production of the F-22 air-superiority fighter. The ATF competition judged the F-22 to have significant strengths including well-balanced design and the F119 engines's superior margin for growth. Equally important were the F-22 team's program to mature the design and its plans to integrate development of airframe, engine, avionics, and support and training systems. Iterative design of the internal structure is an integral part of the development concept, which promises to eliminate design changes almost completely once fabrication begins, thus avoiding cost increases and schedule slips. Consideration is given to the integration of parts and production provided by 26 major subcontractors and 650 suppliers. R.E.P.

N91-31078*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

VIBRATION ANALYSIS OF THE SA349/2 HELICOPTER

RUTH HEFFERNAN, DOMINIQUE PRECETTI, and WAYNE

JOHNSON (Johnson Aeronautics, Palo Alto, CA.) Jan. 1991 102 p

(NASA-TM-102794; A-90083; NAS 1.15:102794) Avail: NTIS HC/MF A06 CSCL 01B

Helicopter airframe vibration is examined using calculations and measurements for the SA349/2 research helicopter. The hub loads, which transmit excitations to the fuselage, are predicted using a comprehensive rotorcraft analysis and correlated with measuring hub loads. The predicted and measured hub loads are then coupled with finite element models representing the SA349/2 fuselage. The resulting vertical acceleration at the pilot seat is examined. Adjustments are made to the airframe structural models to examine the sensitivity of predicted vertical acceleration to the model. Changes of a few percent to the damping and frequency of specific models lead to large reductions in predicted vibration, and to major improvements in the correlations with measured pilot-seat vertical acceleration. Author

N91-31079# Naval Postgraduate School, Monterey, CA.

AN INTEGER PROGRAMMING MODEL FOR NAVY'S MARITIME PATROL AVIATION FLEET M.S. Thesis

ROBERT W. DRASH Sep. 1990 78 p

(AD-A239464) Avail: NTIS HC/MF A05 CSCL 05/1

This thesis details an integer programming model to aid in the modernization of the Navy's Maritime Patrol Aviation fleet. Over a user specified time horizon, the model provides a schedule for when to retire, perform avionics upgrades, or transfer current inventory aircraft from the USN to the USNR. Additionally, the model determines when to open a new aircraft production line and the number of aircraft to procure each year. The model optimizes the modernization schedule while taking into consideration required inventory, minimum required percentage of aircraft containing modern avionics, maximum desired mean aircraft age, budgetary limitations, and production line restrictions. The model minimizes the procurement, operating and maintenance costs using the X-System solver. GRA

N91-32032# National Aerospace Lab., Tokyo (Japan).

PROCEEDINGS OF THE 8TH NAL SYMPOSIUM ON AIRCRAFT COMPUTATIONAL AERODYNAMICS

Nov. 1990 314 p In JAPANESE and ENGLISH Symposium held in Tokyo, Japan, 25-27 Jun. 1990

(NAL-SP-14; ISSN-0289-260X) Avail: NTIS HC/MF A14

The papers presented at the 8th NAL Symposium on Aircraft Computational Aerodynamics are compiled. The following subject areas are covered: computational fluid dynamics, chemically reacting flow, Direct Simulation Monte Carlo method, rarefied gases, grid generation finite difference theory, finite volume method, finite element method, flow visualization, Navier-Stokes equations, laminar and turbulent flows, cascade flow, etc.

N91-32070*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

PRODUCTION TECHNIQUES FOR JET-INDUCED EFFECTS IN HOVER ON STOVL AIRCRAFT

DOUGLAS A. WARDWELL and RICHARD E. KUHN (Kuhn, Richard E., San Diego, CA) Aug. 1991 25 p

(NASA-TM-102818; A-90146; NAS 1.15:102818) Avail: NTIS HC/MF A03 CSCL 01/2

Prediction techniques for jet induced lift effects during hover are available, relatively easy to use, and produce adequate results for preliminary design work. Although deficiencies of the current method were found, it is still currently the best way to estimate jet induced lift effects short of using computational fluid dynamics. Its use is summarized. The new summarized method, represents the first step toward the use of surface pressure data in an empirical method, as opposed to just balance data in the current method, for calculating jet induced effects. Although the new method is currently limited to flat plate configurations having two circular jets of equal thrust, it has the potential of more accurately predicting jet induced effects including a means for estimating the pitching moment in hover. As this method was developed from a very limited amount of data, broader applications of the method require

the inclusion of new data on additional configurations. However, within this small data base, the new method does a better job in predicting jet induced effects in hover than the current method.

Author

N91-32071*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPARISONS OF ELASTIC AND RIGID BLADE-ELEMENT ROTOR MODELS USING PARALLEL PROCESSING TECHNOLOGY FOR PILOTTED SIMULATIONS

GARY HILL, RONALD W. DUVAL, JOHN A. GREEN, and LOC C. HUYNH (Advanced Rotorcraft Technology, Inc., Mountain View, CA.) Jun. 1991 19 p Presented at the Sixteenth European Rotorcraft Forum, Glasgow, Scotland, 18-20 Sep. 1990 (NASA-TM-102859; A-90266; NAS 1.15:102859) Avail: NTIS HC/MF A03 CSCL 01/2

A piloted comparison of rigid and aeroelastic blade-element rotor models was conducted at the Crew Station Research and Development Facility (CSRDF) at Ames Research Center. A simulation development and analysis tool, FLIGHTLAB, was used to implement these models in real time using parallel processing technology. Pilot comments and quantitative analysis performed both on-line and off-line confirmed that elastic degrees of freedom significantly affect perceived handling qualities. Trim comparisons show improved correlation with flight test data when elastic modes are modeled. The results demonstrate the efficiency with which the mathematical modeling sophistication of existing simulation facilities can be upgraded using parallel processing, and the importance of these upgrades to simulation fidelity.

Author

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A91-53242

RECENT PROGRESS ON MESH OPTIMIZATION

OLIVIER-PIERRE JACQUOTTE (ONERA, Chatillon, France) (International Conference on Numerical Grid Generation in Computational Fluid Dynamics, 3rd, Barcelona, Spain, June 3-7, 1991) ONERA, TP no. 1991-81, 1991, 17 p. Research supported by CEC. refs (ONERA, TP NO. 1991-81)

A method for the optimization of multiblock structured grids is reviewed; it relies on a definition of the mesh quality expressed in terms of a measure of the cell deformation with respect to reference cells. Its latest improvements: weighted functional, multiblock algorithm, preconditioning of the algorithm, and use of numerical under-integration are presented. Details on the numerical implementation of the method are given. The results obtained on a grid around a 4-block wing-nacelle configuration are described.

Author

A91-53244

NUMERICAL STUDY OF 2D SUPERSONIC MIXING LAYERS

G. BILLET (ONERA, Chatillon, France) and P. VUILLERMOZ (SEP, Vernon, France) (International Conference on Numerical Methods in Laminar and Turbulent Flow, 7th, Stanford, CA, July 15-19, 1991) ONERA, TP no. 1991-85, 1991, 26 p. refs (ONERA, TP NO. 1991-85)

Supersonic mixing layers are studied by a numerical approach. The model integrates the time-averaged 2D Navier-Stokes equations with a turbulence model (Baldwin-Lomax or k-epsilon model) and a molecular diffusion model (Fick's law). This simulation allows numerical Reynolds numbers comparable with experimental Reynolds numbers. The effects of density ratio and the convective Mach number on the global quantities as the growth rate of the mixing layer are studied. In a particular case results obtained with

the classic k-epsilon model and a 'compressible' K-epsilon model have been compared and the existence of zones where the turbulent shearing stress changes of sign has been observed. Another study has shown the effect of the upstream profile on the instability of a hydrogen-nitrogen mixing layer. The influence of an upstream distortion has been demonstrated when the frequency of this perturbation is close to the natural unstable frequencies of the mixing layer.

Author

A91-53382

ADAPTIVITY FOR COMPRESSIBLE FLOW COMPUTATIONS USING POINT EMBEDDING ON 2-D STRUCTURED MULTIBLOCK MESHES

A. EVANS, M. J. MARCHANT, J. SZMELTER, and N. P. WEATHERILL (Swansea, University College, Wales) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 32, Sept. 1991, p. 895-919. Research supported by Royal Aerospace Establishment and CEC. refs Copyright

A method of local point embedding of multiblock structured meshes is described. A quadtree data structure is used to ensure an efficient, well-defined data format. Two conservative treatments within the flow solver of the interfaces created by local point enrichment are discussed. These treatments are both conservative and lead to accurate flow solutions. Applications of the method to 2D aerodynamic geometries are presented with the adaptivity procedure controlled via measures of gradients in flow variables. The benefits of locally enriched adapted meshes are demonstrated by the solutions.

C.D.

A91-53383

THE ADAPTATION OF STRUCTURED GRIDS TO NUMERICAL SOLUTIONS FOR TRANSONIC FLOW

DAVID CATHERALL (Royal Aerospace Establishment, Farnborough, England) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 32, Sept. 1991, p. 921-937. refs Copyright

Methods are described for adapting a structured grid in response to a numerical solution, so that grid nodes become clustered where 'solution activity' is high, the aim being to reduce solution truncation errors without increasing the number of grid nodes employed, or modifying their connectivity. After introducing the concept of 'equidistribution', and discussing options for the measurement of solution activity, the paper concentrates mainly on two alternative techniques for producing smooth, regular grids which apply constraints on this equidistribution. The first technique described is based on a spring analogy, and is demonstrated here with examples of two- and three-dimensional inviscid flows, and with two-dimensional viscous flows. The second technique employs a Poisson grid generator with adaptive terms included in the control functions, and is demonstrated with a two-dimensional inviscid flow. A third method is then introduced, termed the LPE method, which allows a compromise to be chosen between grids generated by solving Laplace equations, Poisson equations and equidistribution equations. Since this method is still being developed, results are currently limited and tentative.

Author

A91-53726

AIAA APPLIED AERODYNAMICS CONFERENCE, 9TH, BALTIMORE, MD, SEPT. 23-25, 1991, TECHNICAL PAPERS. VOLS. 1 & 2

Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. Vol. 1, 619 p.; vol. 2, 491 p. For individual items see A91-53727 to A91-53823.

Copyright

The present conference on applied aerodynamics encompasses computational fluid dynamics, drag prediction/analysis, experimental aerodynamics, high angles of attack, rotor/propeller aerodynamics, super/hypersonic aerodynamics, unsteady aerodynamics, vortex physics, high-speed civil-transport aeroacoustics, and airfoil/wing aerodynamics. Specific issues addressed include high-speed civil-transport air-breathing

propulsion, generic hypersonic inlet-module analysis, an investigation on spoiler effects, high-alpha vehicle dynamics, space-station resource node flow-field analysis, a numerical simulation of sabot discard aerodynamics, and vortex control using pneumatic blowing. Also addressed are Navier-Stokes solutions for the F/A-18 Wing-LEX fuselage, tail venting for enhanced yaw damping at spinning conditions, an investigation of rotor wake interactions with a body in low-speed forward flight, and multigrid calculations of 3D viscous cascade flows. C.C.S.

A91-53728#

VALIDATION OF 3-D NAVIER-STOKES SIMULATIONS FOR TRANSONIC FLOWS ABOUT BOEING 747-200 WING-FUSELAGE COMBINATION

RYOZO ITO (Daiko Denshi Tsushin, Ltd., Tokyo, Japan) and SUSUMU TAKANASHI (National Aerospace Laboratory, Chofu, Japan) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 10-22. refs (AIAA PAPER 91-3202) Copyright

A 3D Navier-Stokes (NS) code is employed to simulate a wing-fuselage configuration designed for wind-tunnel tests, and the experimental and analytical data are compared. A single grid system in C-O topology is used with the 3D Reynolds-averaged thin-layer NS equations for the code. Several grid types are examined to determine which offers satisfactory grid size and grid-point distribution for the viscous transonic flow simulations. The results indicate that the experimental and analytical data produce similar values for the pressure distributions on the wing and values such as total lift. The code cannot simulate the separated flow, however, because the effect of the artificial dissipation on the numerical solution is not negligible and the turbulence model does not account for separated flow. C.C.S.

A91-53729*# Lockheed Engineering and Sciences Co., Houston, TX.

IMPLEMENTATION OF WALL BOUNDARY CONDITIONS FOR TRANSPIRATION IN F3D THIN-LAYER NAVIER-STOKES CODE

M. KANDULA (Lockheed Engineering and Sciences Co., Houston, TX) and F. W. MARTIN, JR. (NASA, Johnson Space Center, Houston, TX) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 23-31. refs (Contract NAS9-17900)

(AIAA PAPER 91-3204) Copyright

Numerical boundary conditions for mass injection/suction at the wall are incorporated in the thin-layer Navier-Stokes code, F3D. The accuracy of the boundary conditions and the code is assessed by a detailed comparison of the predictions of velocity distributions and skin-friction coefficients with exact similarity solutions for laminar flow over a flat plate with variable blowing/suction, and measurements for turbulent flow past a flat plate with uniform blowing. In laminar flow, F3D predictions for friction coefficient compare well with exact similarity solution with and without suction, but produces large errors at moderate-to-large values of blowing. A slight Mach number dependence of skin-friction coefficient due to blowing in turbulent flow is computed by F3D code. Predicted surface pressures for turbulent flow past an airfoil with mass injection are in qualitative agreement with measurements for a flat plate. Author

A91-53730*#

TRANSONIC NAVIER-STOKES FLOW COMPUTATIONS OVER WING-FUSELAGE GEOMETRIES

S. AGRAWAL, T. A. KINARD (McDonnell Aircraft Co., Saint Louis, MO), and V. N. VATSA (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p.

32-42. refs

(AIAA PAPER 91-3205) Copyright

The steady-state transonic viscous flows over two wing-fuselage configurations are solved numerically. The 3D compressible thin-layer Navier-Stokes equations are solved by means of multistage timestepping similar to the Runge-Kutta method. The timestepping technique is applied with a multigrid scheme to make the transonic Navier-Stokes computations using the Baldwin-Lomax turbulence for closure and converging the solution on a grid of 1.52 million grid points with a C-O topology. Both generic and fighter wing-fuselage geometries are solved, and the results are compared to experimental studies. Solution convergence is found to be fast, and the fine grid generates accurate results for both configurations by means of the Baldwin-Lomax turbulence model. Results from the Johnson-King model calculations produce results that are more consistent with experimental results for the fighter configuration. C.C.S.

A91-53731#

ANALYSIS OF HYPERSONIC BLUNT-BODY FLOWS USING A TOTAL VARIATION DIMINISHING (TVD) SCHEME AND THE MACCORMACK SCHEME

MONTGOMERY C. HUGHSON (USAF, Directorate of Flight Systems Engineering, Wright Patterson AFB, OH) and PHILIP S. BERAN (USAF, Institute of Technology, Wright-Patterson AFB, OH) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 43-57. refs

(AIAA PAPER 91-3206)

An explicit, second-order accurate, total-variation-diminishing (TVD) scheme and the MacCormack scheme are applied to the Euler equations in axisymmetric form to study hypersonic blunt-body flows. The modified-flux approach of Harten (1983), with modification by Yee (1987), for 2D flows is extended to treat axisymmetric flows. Calculated surface-pressure distributions for the steady-state blunt-body problem are compared to theory, results of the MacCormack scheme, and experimental data for Mach numbers of 3.0 and 4.03. Additionally, the TVD and MacCormack schemes are used to simulate numerically the unsteady shock-impingement on a sphere. Analysis of the numerical simulations provide suitable ranges of values for the entropy correction parameter and the Courant number. A brief comparison of computer run times for the two schemes is also presented. The high-resolution, shock-capturing capability and robustness of the TVD scheme is shown. Author

A91-53732*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

NAVIER-STOKES SIMULATION OF NOZZLE-AFTERBODY FLOWS WITH JETS AT OFF-DESIGN CONDITIONS

WILLIAM B. COMPTON, III (NASA, Langley Research Center, Hampton, VA) and KHALED S. ABDOL-HAMID (Analytical Services and Materials, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 58-69. refs

(AIAA PAPER 91-3207) Copyright

Three-dimensional Navier-Stokes simulations are made for the external flow, the jet-exhaust plume, and the internal nozzle flow of a nonaxisymmetric nozzle typical of those advocated for advanced fighter airplanes. Solutions are presented for free-stream Mach numbers of 0.80, 0.94, and 1.20 at an angle of attack of 0 deg and a Reynolds number of 20×10^6 to the 6th. Jet-total-pressure ratios ranging from 1.5 to 9.8, i.e., from below to above the design pressure ratio of 4.25, are investigated. The results are compared to wind-tunnel data. The calculations successfully predict many trends and features of the external and internal flow. Author

A91-53733#

INVESTIGATION OF THE VORTEX FLOW OVER A 76/60-DEG DOUBLE DELTA WING AT 20 DEG INCIDENCE

N. G. VERHAAGEN (Delft University of Technology, Netherlands)

and J. E. J. MASELAND IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 70-80. refs (AIAA PAPER 91-3208) Copyright

A low-speed wind-tunnel investigation is described of the characteristics of the vortex flow over a 76/60-deg double-delta wing at 20 deg incidence. The objective of the investigation is to support the development and validation of numerical codes by generating experimental data on the vortex interaction downstream of the strake-wing leading-edge kink of a double-delta wing. Detailed flowfield surveys and surface-pressure measurements provide data on the pressure and velocity distribution at various chordwise stations. The experimental results are compared with results from numerical codes. Author

A91-53734*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

GENERIC HYPERSONIC INLET MODULE ANALYSIS

CHARLES E. COCKRELL, JR. and LAWRENCE D. HUEBNER (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 81-91. refs (AIAA PAPER 91-3209) Copyright

A computational study associated with an internal inlet drag analysis was performed for a generic hypersonic inlet module. The purpose of this study was to determine the feasibility of computing the internal drag force for a generic scramjet engine module using computational methods. The computational study consisted of obtaining two-dimensional (2D) and three-dimensional (3D) computational fluid dynamics (CFD) solutions using the Euler and parabolized Navier-Stokes (PNS) equations. The solution accuracy was assessed by comparisons with experimental pitot pressure data. The CFD analysis indicates that the 3D PNS solutions show the best agreement with experimental pitot pressure data. The internal inlet drag analysis consisted of obtaining drag force predictions based on experimental data and 3D CFD solutions. A comparative assessment of each of the drag prediction methods is made and the sensitivity of CFD drag values to computational procedures is documented. The analysis indicates that the CFD drag predictions are highly sensitive to the computational procedure used. Author

A91-53737#

AN EXPERIMENTAL INVESTIGATION ON SPOILER EFFECTS

A. M. AL-BAHI and M. A. GHAZI (King Abdulaziz University, Jeddah, Saudi Arabia) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 109-115. refs (AIAA PAPER 91-3214) Copyright

An aircraft model is fitted with several spoiler configurations to determine the effects on geometrical and flow conditions. The lift and pitching moment coefficients are examined for different angles of attack, spoiler deflections, and Reynolds numbers. The spoiler configurations include outboard, inboard, and ground spoilers and are tested separately. At small angles of attack, the spoilers generate lift reduction and a nose-up pitching moment. Aircraft stability is not affected by the spoiler angles, although the spoilers can be used as longitudinal control devices because certain configurations introduce trimmed conditions. Flight spoilers are found to generate less lift reduction than inboard and ground spoilers, and outboard spoilers are the most important in applications as longitudinal control devices. C.C.S.

A91-53738#

EXPERIMENTAL INVESTIGATION OF THE WIND SHEAR EFFECT ON THE AERODYNAMIC FORCES ON A WING

MAHER ALY, IBRAHIM OLWI, ALI AL-BAHI, and MOHAMMAD GHAZI (King Abdulaziz University, Jeddah, Saudi Arabia) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American

Institute of Aeronautics and Astronautics, 1991, p. 116-122. Research supported by King Abdulaziz University. refs (AIAA PAPER 91-3216) Copyright

A rectangular symmetrical wing model is studied in a low-speed wind tunnel to examine the effects of wind shear by measuring lift, drag, and pitching moment. The model is subjected to a uniform flow normal to the free stream, and a three-component balance system attached to a computer allowed measurement of the three moments. The uniform flow impinging on the model simulates the wind shear, and the effect of the shear is found to cause a significant reduction in lift and a similarly significant increase in drag. Increases in the wind-shear velocity are found to increase the stall angle of attack and therefore the maximum lift coefficient. It is concluded from the results of the investigation that when a microburst is encountered both thrust and angle of attack should be boosted to counteract the effects. C.C.S.

A91-53739*# Illinois Univ., Urbana.

AERODYNAMIC MEASUREMENTS ON A FINITE WING WITH SIMULATED ICE

M. B. BRAGG, A. KHODADOUST, R. SOLTANI, S. WELLS, and M. KERHO (Illinois, University, Urbana) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 123-132. Research supported by NASA. refs (AIAA PAPER 91-3217) Copyright

The effect of a simulated glaze ice accretion on the aerodynamic performance of a three-dimensional straight and swept wing is studied experimentally. A semispan wing of effective aspect ratio five was mounted from the sidewall of the UIUC subsonic wind tunnel. The model uses an NACA 0012 airfoil section on a rectangular planform with interchangeable tip and root sections to allow for 0- and 30-deg sweep. A sidewall suction system is used to minimize the tunnel boundary-layer interaction with the model. A three-component sidewall balance has been designed, built and used to measure lift, drag and pitching moment on the clean and iced model. Fluorescent oil flow visualization has been performed on the iced model and reveals extensive spanwise flow in the separation bubble aft of the upper surface horn. These results are compared to computational results for the surface pressures, span loads and surface oil flow. Author

A91-53740#

THE IMPACT OF APEX-FLAP ON VORTEX-FLAPPED DELTA AND DOUBLE DELTA WINGS

TING-DING HSING, ZI-QIANG ZHANG, and FENG-GAN ZHUANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 133-143. Research supported by NNSFC. refs (AIAA PAPER 91-3218) Copyright

An experimental investigation is reported in which the effect of adding an apex flap to two wing configurations is studied. Two vortex-flapped wing-body models - delta and double-delta types - are tested with and without the apex flap in conditions with or without yaw in a circular low-speed wind tunnel. An internally mounted strain-gage balance is employed to measure the test models at different angles of attack and sideslip. It is determined that drag can be reduced by deflecting the apex flap downwards and thereby increase the lift-to-drag ratio. An apex flap of the proper dimensions can be added to a vortex-flapped wing to effectively increase lift under all conditions including that of sideslip. Mathematical calculations are used to verify the idea that adding the apex flap can compensate for the loss in lift associated with adding vortex flaps. C.C.S.

A91-53742#

CRITICAL ISSUES IN HIGH-ALPHA VEHICLE DYNAMICS

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) IN: AIAA Applied Aerodynamics Conference,

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9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 152-179. Research supported by Lockheed Missiles and Space Co., Inc. refs
(Contract F33615-87-C-3607)
(AIAA PAPER 91-3221) Copyright

A general overview of the existing database relevant to high-alpha aerospace vehicles is presented to assess the present capacity for predicting high-alpha aerodynamics. Four critical issues are identified and examined with respect to the unsteady separated flow dynamics of the vehicles. The cause and effect are examined of asymmetric forebody flow separation with associated vortices. The study also considers the effects of the asymmetry and breakdown of leading edge vortices and that of vehicle motion on dynamic airfoil stall. Available data from subscale testing is extrapolated to analyze the nature of full-scale free flight for the high-alpha vehicles. It is determined that a strong coupling exists between boundary layer transition and vehicle motion, and some subscale results contradict full-scale flight results. C.C.S.

A91-53743#

EFFECT OF CANARD DEFLECTION ON ENHANCED LIFT FOR A CLOSE-COUPLED-CANARD CONFIGURATION

RICHARD M. HOWARD (U.S. Naval Postgraduate School, Monterey, CA) and JOHN M. KERSH, JR. (U.S. Navy, Washington, DC) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 180-189. Research supported by U.S. Navy. refs
(AIAA PAPER 91-3222)

A wind-tunnel study was carried out to consider the effect of canard deflection on optimal lift enhancement for a close-coupled-canard configuration. Lift and drag measurements and surface-flow-visualization results are presented. The optimal deflection of the canard generally increased the coefficient of lift by 4 percent over the zero-deflection case. Yet this 4-percent increase in the total lift coefficient equaled up to 40 percent of the total lift enhancement. Flow-visualization studies indicated that the enhancing mechanism differed for the low-angle-of-attack, pre-stall case (first stall) as compared to the post-stall, high-angle-of-attack case where a strong wing vortex existed. Maximum enhancement occurred at the first stall, where the lift coefficient was increased by 34 percent, after taking into account the added reference area. Author

A91-53744#

AN EXPERIMENTAL INVESTIGATION OF EMPENNAGE BUFFETING

D. E. BEAN and N. J. WOOD (Bath, University, England) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 190-197. refs
(AIAA PAPER 91-3224) Copyright

Fin-buffeting characteristics are determined experimentally for several fin geometries to analyze the effects of flight in the high-alpha regime. Two cropped 60-degree generic delta wings with various leading-edge profiles are subjected to wind-tunnel conditions that simulate frequencies of buffet forcing. The vortical flow is examined by means of static pressure data and laser-light sheet flow visualizations which can give quantifiable results. The first bending mode produced the primary example of the buffet response, and maximum single-fin buffeting is found to be related to the wing-stall point. Buffeting for twin fins, however, is not related to wing stall, and two peaks in the response curve are noted. Maximum buffeting for both conditions is discussed, and increased lateral fin separation shifts the buffet peaks to a lower angle of attack. C.C.S.

A91-53745*# Toledo Univ., OH.

WING ROCK SUPPRESSION USING FOREBODY VORTEX CONTROL

T. T. NG (Toledo, University, OH), L. Y. ONG, C. J. SUAREZ, and G. N. MALCOLM (Eidetics International, Inc., Torrance, CA) IN:

AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 198-211. refs
(Contract NAS2-12989)
(AIAA PAPER 91-3227) Copyright

Static and free-to-roll tests were conducted in a water tunnel with a configuration that consisted of a highly-slender forebody and 78-deg sweep delta wings. Flow visualization was performed and the roll angle histories were obtained. The fluid mechanisms governing the wing rock of this configuration were identified. Different means of suppressing wing rock by controlling the forebody vortices using small blowing jets were also explored. Steady blowing was found to be capable of suppressing wing rock, but significant vortex asymmetries had to be induced at the same time. On the other hand, alternating pulsed blowing on the left and right sides of the forebody was demonstrated to be potentially an effective means of suppressing wing rock and eliminating large asymmetric moments at high angles of attack. Author

A91-53746*# Maryland Univ., College Park.

INVESTIGATION OF ROTOR WAKE INTERACTIONS WITH A BODY IN LOW SPEED FORWARD FLIGHT

NAI-PEI BI, J. G. LEISHMAN, and GILBERT L. CROUSE, JR. (Maryland, University, College Park) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 212-221. refs
(Contract DAAL03-88-C-002; NAG2-607)
(AIAA PAPER 91-3228) Copyright

Wind tunnel tests are reported in which the unsteady aerodynamic interactions between rotor wake and a body are examined for the case of low-speed flight. A wide-field shadowgraph is employed to visualize the rotor-tip vortices during the interactions, and the pressure signatures are measured and correlated with wake trajectories. Consideration is given to unsteady potential-flow theory to estimate the pressure loads from measured wake trajectories. The pressure signatures are very different upstream of, downstream of, and at the wake-impingement point, at which point large transient loads are transferred to the body. Rotor wake is characterized, and the wake filaments impinge on the advancing side of the body first. The pressure signatures present a complex and varying range of patterns, but it is determined that vortex surface interactions can be modeled using potential-flow analysis. C.C.S.

A91-53747*# Continuum Dynamics, Inc., Princeton, NJ.

COMPUTATION OF ROTOR AERODYNAMIC LOADS WITH A CONSTANT VORTICITY CONTOUR FREE WAKE MODEL

TODD R. QUACKENBUSH, DANIEL A. WACHSPRESS, and ALEXANDER H. BOSCHITSCH (Continuum Dynamics, Inc., Princeton, NJ) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 222-236. refs
(Contract NAS2-12838)
(AIAA PAPER 91-3229) Copyright

An analytical method is presented which facilitates the study of isolated rotors with an improved approach to wake simulation. Vortex filaments are simulated along contours of constant sheet strength for the sheet of vorticity resulting from each rotor blade. Curved vortex elements comprise the filaments which can be distorted by the local velocity field. Called the Constant Vorticity Contour wake model, the approach permits the simulation of the blades' wakes corresponding to the full span of the rotor blade. The discretization of the wake of the rotor blade produces spacing and structure that are consistent with the spatial and temporal variations in the loading. A vortex-lattice aerodynamic model of the blade is also included which introduces a finite-element structural model of the blade and consideration of the force and moment trim analysis. Results of the present version of the simulation, called RotorCRAFT, are found to correlate well with H-34 flight-test data. C.C.S.

A91-53748#

UNSTEADY INTERACTIONAL EFFECTS BETWEEN A PROPELLER AND A FIXED WING

D. FAVIER, C. MARESCA, A. AGNES (Aix-Marseille II, Université, Marseille, France), and J.-Y. CHIARAMONTE IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 237-245. refs (AIAA PAPER 91-3231) Copyright

Experimental and numerical approaches have been used to investigate the instantaneous interaction effects between a propeller and a fixed wing. The experimental study includes instantaneous pressure measurements on the wing surface, as well as instantaneous velocity measurements in the wake of the propeller and around the wing surface. The wake geometry distortion due to the wing is provided by measurements of the tip vortex paths associated to different blade azimuthal positions. This distorted wake geometry is used as an input in the numerical approach to calculate the vortical wake influence on the spanwise wing loading distribution. The prediction efficiency of the calculation model is checked by comparison with mean and instantaneous pressure distributions measured at different spanwise sections of the wing. Author

A91-53749*# Maryland Univ., College Park.

FUNDAMENTAL STUDIES OF ROTOR WAKES IN LOW SPEED FORWARD FLIGHT USING WIDE-FIELD SHADOWGRAPHY

J. G. LEISHMAN and A. BAGAI (Maryland, University, College Park) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 246-258. refs

(Contract NAG2-607; DAAL03-88-C-002)

(AIAA PAPER 91-3232) Copyright

Experiments were conducted using the wide-field shadowgraph method to visualize the wake geometry from a helicopter rotor in low speed forward flight. The experiments were performed with an isolated rotor and with a body representing a helicopter fuselage. Particular attention was paid to documenting the isolated rotor wake geometry, blade vortex interaction phenomena near the rotor plane, the distortion made to the wake due to the presence of the body, and detailing the interaction of the tip vortices with the body surface. Quantitative measurements were made of the wake trajectories as functions of wake age, as well as estimates of the tip vortex core radius. The results have provided many details of the rotor wake structure that are useful for validating rotor wake and rotor/body interactional models in forward flight. The use of the wide-field shadowgraph method offers an important tool for visualizing rotor wake vortices, and helping to understand the complex three-dimensional nature of rotor wakes in forward flight. Author

A91-53751#

A COMPACT HIGHER ORDER CHARACTERISTIC-BASED EULER SOLVER FOR UNSTRUCTURED GRIDS

D. W. HALT (McDonnell Aircraft Co., Saint Louis, MO) and R. K. AGARWAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 269-278. refs

(AIAA PAPER 91-3234) Copyright

Two new methods are presented for solving the Euler equations using a compact higher order polynomial reconstruction technique on unstructured grids. The methods use a characteristic-based approach with a cell-centered finite volume method. For transonic Ringleb flow, computations are performed for first order to fourth order accuracy and are compared with the hodograph solution. Results for a 10 degree ramp case are also presented. An analysis is performed which demonstrates that the higher order method is an order of magnitude more efficient than the lower order method in modeling the flow for moderate to fine error tolerances. Accuracy,

speed and memory requirements are evaluated in the efficiency study. Author

A91-53753#

APPLICATION OF AN EFFICIENT 3-D MULTIGRID EULER METHOD (MGAERO) TO COMPLETE AIRCRAFT CONFIGURATIONS

D. M. TIDD, D. J. STRASH (Analytical Methods, Inc., Redmond, WA), B. EPSTEIN, A. LUNTZ, A. NACHSHON, and T. RUBIN (Israel Aircraft Industries, Ltd., Tel Aviv) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 288-296. refs (AIAA PAPER 91-3236) Copyright

The numerical formulation and structure of MGAERO, a three-dimensional Euler code, are briefly reviewed, and results for a series of configurations of increasing complexity are reported. It is shown that the use of Cartesian grid cells is a practical technique in a multigrid approach. MGAERO is shown to be capable of accurately computing flows about complex configurations for engineering applications and for the analysis of complete aircraft. An accurate shock capturing capability is obtained in the transonic regime through local grid refinement. V.L.

A91-53759*# Planning Research Corp., Edwards, CA.

IN-FLIGHT LEADING-EDGE VORTEX FLOW-FIELD SURVEY MEASUREMENTS ON A F-18 AIRCRAFT AT HIGH ANGLE OF ATTACK

DAVID M. RICHWINE (PRC, Inc., Edwards, CA) and DAVID F. FISHER (NASA, Flight Research Center, Edwards, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 346-369. refs (AIAA PAPER 91-3248) Copyright

A rotating rake with 16 hemispherical-tipped five-hole probes was used to obtain flow-field measurements of the leading-edge-extension (LEX) vortex of the F-18 aircraft. The measurements were carried out under 1-g flight conditions at quasi-stabilized angles of attack of 10-52 deg and at Reynolds numbers based on a mean aerodynamic cord up to 16×10^6 to the 6th. Correlations with surface pressure, flow visualization, and computational fluid dynamics results are presented for angles of attack of 19 and 30 deg. V.L.

A91-53760*# MCAT Inst., Moffett Field, CA.

COMPUTATIONAL OPTIMIZATION OF A PNEUMATIC FOREBODY FLOW CONTROL CONCEPT

KEN GEE (MCAT Institute, Moffett Field, CA), DOMINGO TAVELLA (Stanford University, CA), and LEWIS B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 370-380. refs (AIAA PAPER 91-3249) Copyright

The effectiveness of a tangential slot blowing concept for generating lateral control forces on an aircraft forebody is analyzed using computational fluid dynamics. The flow about a fighter forebody is computed using a multiple-zone, thin-layer Navier-Stokes code. Tangential slot blowing is modeled by the use of an actuator plane. The effects of slot location and slot length on the efficiency of the system are analyzed. Results of the study indicate that placement of the slot near the nose of the aircraft greatly enhances the efficiency of the system, while the length and circumferential location of the slot are of secondary importance. Efficiency is defined by the amount of side force or yawing moment obtained per unit blowing coefficient. The effect of sideslip on the system is also analyzed. The system is able to generate incremental changes in forces and moments in flows with sideslip angles up to 10 deg comparable to those obtained at zero sideslip. These results are used to determine a baseline configuration for an experimental study of the tangential slot blowing concept. Author

A91-53761#

AN EXPERIMENTAL INVESTIGATION OF THE EFFECTS OF LEADING EDGE EXTENSIONS AND FOREBODY FLOW SEPARATORS ON THE FOREBODY-VORTEX INDUCED AERODYNAMICS OF A GENERIC FIGHTER CONFIGURATION

MARK H. NORRIS (Lockheed Aeronautical Systems Co., Marietta, GA) and C. E. LAN (Kansas, University, Lawrence) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 381-389. refs (Contract F33615-87-C-3607)

(AIAA PAPER 91-3251) Copyright

A generic fighter configuration was tested in a low-speed wind tunnel at a Reynolds number of 0.67×10^6 to the 6th to determine the effects of leading-edge extensions and forebody flow separators on the forebody-induced aerodynamics. At zero sideslip, the leading-edge extensions are found to increase the forebody and total side force and yawing moment. Significant reductions in the untrimmed yawing moment are obtained with forebody flow separators mounted on either the windward or leeward side of the forebody. In sideslip, a configuration with strong axisymmetric forebody vortex flow is characterized by negative directional stability and nonlinear variations with angle of attack. V.L.

A91-53762*# North Carolina State Univ., Raleigh.

AN EXPERIMENTAL STUDY OF THE EFFECTS OF AFT BLOWING ON A 3.0 CALIBER TANGENT OGIVE BODY AT HIGH ANGLES OF ATTACK

NATHAN M. GITTNER and NDAONA CHOKANI (North Carolina State University, Raleigh) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 390-399. refs (Contract NCC1-46)

(AIAA PAPER 91-3252) Copyright

An experimental study of the effects of aft blowing on the forebody vortex asymmetry over a 3.0 caliber tangent ogive body at high angles of attack was conducted. The tip of the ogive body was equipped with a single blowing nozzle whose position could be adjusted. The tests were conducted in a subsonic wind tunnel at laminar flow conditions. The effects of model roll, angle of attack, blowing coefficient, and blowing nozzle axial position were independently studied. Surface pressure measurements and flow visualization results were obtained. Aft blowing was observed to alleviate the degree of vortex asymmetry at all angles of attack. The blowing was found to be more effective at the higher angles of attack. However, proportional control of the degree of vortex asymmetry was not observed, because the initial flowfield was highly asymmetric. Author

A91-53763*# Stanford Univ., CA.

A NUMERICAL AND EXPERIMENTAL STUDY OF TANGENTIAL JET BLOWING APPLIED TO BODIES AT HIGH ANGLES OF ATTACK

G. I. FONT, Z. Z. CELIK, and L. ROBERTS (Stanford University, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 400-411. refs

(Contract NCC2-55)

(AIAA PAPER 91-3253) Copyright

The effects of tangential jet blowing on the vortical structures developing about the fuselage of a missile or aircraft at high angle of attack are investigated numerically and experimentally. Computations are carried out for fully laminar and fully turbulent flows, and the results are compared with flow visualization data. It is shown that turbulent computations are more accurate in describing the flow behavior. The actuator plane method is shown to be sufficiently accurate in modeling the essential flow physics of a tangential jet. V.L.

A91-53764#

FOREBODY VORTEX CONTROL USING SLOT BLOWING

T. T. NG (Toledo, University, OH), CARLOS J. SUAREZ, and GERALD N. MALCOLM (Eidetics International, Inc., Torrance, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 412-422. refs

(AIAA PAPER 91-3254) Copyright

Water tunnel experiments were conducted on a forebody model to investigate the mechanism of forebody vortex control by slot blowing and the effectiveness of slot blowing under conditions of strongly asymmetric baseline flow. It is shown that large controlled yawing moments can be generated by very low rates of blowing from a slot along the forebody. The effectiveness is strongly dependent on specific combinations of the baseline asymmetry, blowing rate, slot length, and slot location. Two of the local effects of blowing are to delay the primary separation and to create a vortical structure at high blowing rates. V.L.

A91-53767#

SOME SEPARATION CHARACTERISTICS ON THE OGIVE NOSED SLENDER BODY IN SUPERSONIC FLOWS

NANQIAN CHEN, LI SU, and XIAOSHEN YU (Beijing University of Aeronautics and Astronautics, People's Republic of China) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 444-450. refs (AIAA PAPER 91-3258) Copyright

The oil flow method, color schlieren visualizations, spatial pitot, and surface static pressure measurements were used to study the supersonic separation characteristics on a pointed slender body, an ogive nose with a fineness ratio of 2, and a cylinder afterbody with a fineness ratio of 10. Open separations were observed at Mach 1.5 and 2 and angle of attack 6-20 deg. The starting positions of the separation lines were behind the shoulder and related to the supersonic expansion flow field and the axial favorable pressure gradients on the nose. Two minimum static pressure loops seem to be associated with the starting positions of the separation lines. V.L.

A91-53771#

THE LOADING CHARACTERISTICS OF FINITE WINGS UNDERGOING RAPID UNSTEADY MOTIONS - A THEORETICAL TREATMENT

ERIC J. JUMPER and RONALD J. HUGO (Notre Dame, University, IN) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 483-492. Research supported by McDonnell Douglas Corp. refs (AIAA PAPER 91-3263) Copyright

An unsteady lifting-line method is proposed for determining spanwise loading on a wing undergoing arbitrary dynamic motions. It is shown that the method is capable of predicting span loading as well or better than an unsteady vortex-lattice method and a constant-source, constant-doublet paneling method. A comparison of the method with experimental data confirms the correctness of the modeling of the physics of unsteady wing loading. The applicability limits of the method are defined. V.L.

A91-53772#

THREE-DIMENSIONAL FLOW FIELD KINEMATICS NEAR THE ROOT OF AN OSCILLATING WING

J. D. KLINGE, S. J. SCHRECK, M. C. ROBINSON, and M. W. LUTTGES (Colorado, University, Boulder; USAF, Frank J. Seiler Research Laboratory, Colorado Springs) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 493-506. refs (Contract AF-AFOSR-88-0272; F49620-88-C-0053; F49620-90-C-0076)

(AIAA PAPER 91-3264)

Forced unsteady separated flows were studied near the root of a wing undergoing sinusoidal pitch oscillations at low Reynolds numbers for various reduced frequencies and mean pitch angles.

Vortex initiation, development and aerodynamic influences were characterized using flow visualization, hot-wire anemometry, surface static pressure measurements, and force balance measurements. The structure and development of leading edge and shear layer vortices on the wing upper surface varied temporally and spatially with different parameter combinations. At the splitter plate and wing boundary layer junction a weak interaction vortex appeared. This vortex was suppressed during the leading edge vortex development and convection interval. Peak suction forces produced by unsteady flow structures on the airfoil surface were closely tied to vortex convection and dissipation. Forces measured on the splitter plate were a result of the periodic vortex formation on the upper wing surface and the flow stagnation that occurred at high instantaneous angles of attack on the lower wing surface.

Author

A91-53774#

DEVELOPMENT OF AN UNSTEADY INCOMPRESSIBLE NAVIER-STOKES SOLVER AND APPLICATION TO THE COMPUTATIONS OF SEPARATED FLOWS

HONAM OK and D. S. EBERHARDT (Washington, University, Seattle) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 514-523. refs (AIAA PAPER 91-3266) Copyright

A point symmetric Gauss-Seidel relaxation scheme is used for the pseudo-compressibility formulation of the two-dimensional incompressible Navier-Stokes equations for both steady and time-accurate flows. Calculations for both viscous and inviscid flows are presented, as are solutions for flows over a circular cylinder and an airfoil at high angle of attack with periodic vortex shedding. Good agreement between the calculations and experimental data demonstrates the efficiency of the method in solving unsteady Navier-Stokes equations.

V.L.

A91-53775*# Notre Dame Univ., IN.

A STUDY OF HIGH-ALPHA DYNAMICS AND FLOW VISUALIZATION FOR A 2.5-PERCENT MODEL OF THE F-18 HARV UNDERGOING WING ROCK

THOMAS QUAST, ROBERT C. NELSON (Notre Dame, University, IN), and DAVID F. FISHER (NASA, Flight Research Center, Edwards, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 524-533. refs (Contract NCA2-513)

(AIAA PAPER 91-3267) Copyright

Free-to-roll experiments and flow visualization studies have been conducted for a 2.5-percent model of the F-18 undergoing unsteady wing rock oscillations. Data have been acquired in the form of roll angle time histories as well as video recordings and 35 mm photography of the forebody and leading edge extension vortices. The time histories were differentiated to produce angular velocity and angular acceleration. From this the roll moment as a function of time and/or roll angle could be estimated. A thorough analysis of the data has revealed a genuine wing-rock phenomenon. Off-surface flow visualization was used to identify the forebody and LEX vortex core positions and their interaction in both static and dynamic configurations. A direct correlation between the dynamic data and visualized vortex activity during the wing-rock motion has been made.

Author

A91-53776*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AERODYNAMICS OF AIRFOILS WITH VORTEX TRAPPED BY TWO SPANWISE FENCES

VERNON J. ROSSOW (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 534-544. refs (AIAA PAPER 91-3269) Copyright

An airfoil configuration is presented whose lift is enhanced by a trapped-vortex flow field. Based on the research to date, it is recommended that two spanwise fences be used to enclose the trapped vortex and that the fence heights be adjusted so that the equilibrium condition can be achieved with little or no mass removal from the core region of the vortex. It is also shown that the vortex bubble can be located fore and aft on the airfoil to control aerodynamic parameters, such as the pitching moment. Applications of the high-lift concept presented here are briefly discussed.

V.L.

A91-53777#

EXPERIMENTAL STUDY OF SHOCK-VORTEX INTERACTION IN A MACH 3 STREAM

IRAJ M. KALKHORAN, PASQUALE M. SFORZA, and FRANK Y. WANG (Polytechnic University, Farmingdale, NY) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 545-550. refs (AIAA PAPER 91-3270) Copyright

An experimental investigation of interactions between tip vortices and shock waves of various strength was conducted in the Mach 3 blowdown supersonic wind tunnel at Polytechnic University. The interaction scheme involved positioning a shock wave generator upstream of a semispan wing vortex generator such that tip vortices generated from the lifting surface arbitrarily interacted with shock waves. The resulting interaction was found to be highly unsteady and the observed structure of the flow varied appreciably with shock wave strength. For the case of tip vortices intersecting bow shock waves in front of blunt bodies, formation of conical shock waves were observed.

Author

A91-53778*# California Polytechnic State Univ., San Luis Obispo.

EXPERIMENTAL ANALYSIS OF VORTEX TRAPPING TECHNIQUES

TODD W. RIDDLE, JIN TSO, RUSSELL M. CUMMINGS (California Polytechnic State University, San Luis Obispo), and ALAN J. WADCOCK (Sterling Software, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 551-560. refs (Contract NCC2-684)

(AIAA PAPER 91-3271) Copyright

The use of suction to trap a vortex is investigated experimentally. Vortex trapping using a finite sink and cross-flow obstructions is shown to be viable in the case of low-speed flow over a flat plate airfoil. A dual-fence geometry is found to be more efficient than a backward-facing step due to the greater restriction of vortex movement in the streamwise direction. The backward-facing step geometry provides for an increase in the sink strength required for trapping, while the more efficient dual-fence geometry permits the use of a lower suction force for trapping.

V.L.

A91-53779#

CONTROL OF ASYMMETRIC VORTICAL FLOWS

D. I. GREENWELL and N. J. WOOD (Bath, University, England) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 561-570. refs

(AIAA PAPER 91-3272) Copyright

The concept of asymmetric tangential leading edge blowing (TLEB) for roll control of delta wings is examined with emphasis on the vortex coupling phenomenon. The experimental results presented here confirm the existence of roll control reversal due to prestall vortex coupling, an effect similar to that associated with sideslip. The effect of asymmetric blowing over a wide range of angles of attack and roll angles may be qualitatively described using an 'effective sideslip' and an 'effective vortex angle of attack' analogy. It is noted that a further investigation of the effects of slot geometry, leading edge radius, and wing sweep on lateral

characteristics is required in order to determine the suitability of TLEB as a roll control system. V.L.

A91-53780*# Air Force Wright Aeronautical Labs., Wright-Patterson AFB, OH.

INVESTIGATION OF VORTEX DEVELOPMENT ON A PITCHING SLENDER BODY OF REVOLUTION

M. J. STANEK and M. R. VISBAL (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 571-591. Research supported by NASA. refs

(AIAA PAPER 91-3273)

A computational study of the unsteady flow about a pitching 3.5 caliber tangent ogive forebody is presented. The flow is simulated using the full 3D unsteady Navier-Stokes equations and a time-accurate implicit algorithm. Comparison to available experimental data for a steady 20 deg case is presented as validation. Effects of grid resolution and a comparison of solutions using full Navier-Stokes and the thin-layer approximation are included. The forebody is simulated in a 'pitch-up to 20 deg and hold' maneuver, and two different pitch axis locations are used in the study. Examination of the unsteady vorticity field for the pitch-up cases reveals the formation of strong shear layers as the body decelerates, and their roll-up into vortical structures in a process similar to that observed in airfoil dynamic stall. Pronounced vortex/surface interactions are seen which produce multiple secondary separation regions, ejection of vorticity from the surface, and embedded regions of high suction. Author

A91-53781#

STRAKE VORTEX CONTROL USING PNEUMATIC BLOWING

ROBERT A. ROACH and JOHN M. KUHLMAN (West Virginia University, Morgantown) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 592-605. refs

(Contract F33615-89-C-3001)

(AIAA PAPER 91-3274) Copyright

Laser light sheet flow visualization and laser Doppler anemometry (LDA) have been utilized to study the effectiveness of pneumatic jet blowing in modifying the breakdown and coupling locations of the strake and wing vortices generated over a generic fighter aircraft model with a 55 degree sweep cropped delta wing planform fitted with forebody strakes. Flow visualization has been used to determine jet blowing locations and nozzle configurations which have the maximum beneficial effects of delaying both vortex breakdown, and coupling between the strake and wing vortices. The three component LDA has then been used to study the effects of jet blowing on the strake and wing vortex velocity fields. Author

A91-53782*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EULER/EXPERIMENT CORRELATIONS OF SONIC BOOM PRESSURE SIGNATURES

SUSAN E. CLIFF (NASA, Ames Research Center, Moffett Field, CA) and SCOTT D. THOMAS (Sterling Federal Systems, Inc., Palo Alto, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 606-633. refs

(AIAA PAPER 91-3276) Copyright

The ability of inviscid computational fluid dynamics (CFD) codes to compute sonic boom pressure signatures is examined using three different codes that solve the Euler equations of fluid flow on structured hexahedral and unstructured tetrahedral grids. The results of these Euler codes were evaluated by comparing the computed pressure signatures with near-field experimental data. The computational pressure signatures were determined at distances of one body length or less below the configuration in the plane of symmetry and extrapolated to experimental distances.

The extrapolated CFD pressure signatures gave acceptable correlations with experimental data, provided that fine grids were used near the surface and downstream of the configuration. Author

A91-53783*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

SONIC BOOM PREDICTIONS FOR THREE GENERIC MODELS USING A SOLUTION-ADAPTIVE FULL-POTENTIAL CODE

MICHAEL D. MADSON (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 634-644. refs

(AIAA PAPER 91-3278) Copyright

The TranAir full-potential code, which utilizes a solution-adaptive, unstructured Cartesian grid, was used to compute near-field pressure signatures of three generic supersonic configurations: a cone-cylinder, a low aspect ratio rectangular wing, and a delta-wing/body. TranAir pressure signatures are extrapolated to near- and mid-field distances using a quasi-linear extrapolation technique. Results are compared with existing wind tunnel data and, where possible, with extrapolated experimental data and quasi-linear Whitham-method results. In general, the extrapolated TranAir data is in good agreement with experimental and Whitham-method pressure signatures, but peak pressures are slightly under-predicted. It is thought that computed data obtained too near to the model was the main reason for the discrepancies. Flow-field grid structure was also found to be important in obtaining accurate offbody data. Author

A91-53784*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE SPATIAL CHARACTERISTICS OF THE B HELICAL MODE FOR A CHOKED AXISYMMETRIC NOZZLE

MICHAEL K. PONTON and JOHN M. SEINER (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 645-658. refs

(AIAA PAPER 91-3279) Copyright

An acoustic near-field study was performed for an axisymmetric conical nozzle operated at a fully expanded Mach number of 1.3. The acoustic measurements were performed in the nozzle exit plane using multiple sensors arranged around the periphery of the nozzle. The acquired data were simultaneously digitized. The acoustic spatial characteristics, describing the large scale structure associated with the preferred shear layer instability mode, were determined for the dominant B screech mode. The nozzle was fitted with a lip thickening device to determine the effect of this geometric variable on the spatial structure of the jet. For the thin-lipped configuration, the flapping structure of the B screech mode was found to precess in a time-dependent manner about the jet axis. An increasing of the nozzle exit lip thickness altered the spatial characteristics of this mode from a flapping to a time-dependent flapping or spinning. Using the auto-bicoherence spectrum, frequency dependencies were found to exist in the acoustic data of the thick-lipped configuration. These dependencies may be related to the nonlinearity of the jet and/or the time-dependent nature of the B mode spatial structure. Author

A91-53785#

A SIMPLIFIED E(N) METHOD FOR SEPARATED BOUNDARY LAYERS

PAOLO DINI (Carleton College, Northfield, MN), MICHAEL S. SELIG, and MARK D. MAUGHMER (Pennsylvania State University, University Park) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 659-667. refs

(AIAA PAPER 91-3285) Copyright

An existing transition prediction method for attached, two-dimensional, incompressible boundary layers based on linear

stability analysis is extended to separated, two-dimensional, incompressible boundary layers such as those found in laminar (transitional) separation bubbles. It is shown why the present method, which tracks the growth of disturbances at many different frequencies, is more accurate than the so-called envelope methods. Reliance on a data base of pre-calculated stability characteristics of known velocity profiles makes this method much faster than traditional stability calculations of similar accuracy. The Falkner-Skan self-similar profiles are used for attached flow and a new, very general family of profiles is used for separated flow. Comparisons with measured transition locations inside the bubble show good agreement over the range of chord Reynolds numbers and airfoil angles of attack of interest. Author

A91-53786* Vigyan Research Associates, Inc., Hampton, VA.
EULER STUDY ON POROUS TRANSONIC AIRFOILS WITH A VIEW TOWARD MULTIPOINT DESIGN
 PATER M. HARTWICH (Vigyan, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 668-676. refs (Contract NAS1-18585) (AIAA PAPER 91-3286)

Euler solutions for steady transonic flow (Free-stream Mach 0.63-0.8, $\alpha = 0-2$ deg) over NACA 0012 and supercritical airfoils with solid as well as porous surfaces suggest porosity as a means to realize multipoint design for transonic airfoils. The porous surfaces extend over at least 90 percent of the chord. The porosity distribution is described by a modified sine wave with several amplitudes. Either connected or separated cavities are assumed to lie underneath the upper and lower surfaces. Applied to an NACA 0012 airfoil, porosity generally increases lift, in some instances by up to 65 percent. Porous NACA 0012 airfoils in supercritical flow yield reductions of an order of magnitude in wave drag at constant lift, compared to their solid counterpart. Making the surface of a supercritical airfoil permeable also leads to sizeable reductions in wave drag at constant lift for overspeed conditions. The discussion of the computed results addresses issues such as grid sensitivity and checks for systematic errors. Author

A91-53787*
TRANSONIC AIRFOIL DESIGN BY CONSTRAINED OPTIMIZATION
 K. D. LEE and S. EYI (Illinois, University, Urbana) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 677-687. refs (AIAA PAPER 91-3287) Copyright

An aerodynamic design method is developed which couples flow analysis and numerical optimization to find an airfoil shape with improved aerodynamic performance. The flow analysis code is based on the coupled Euler and boundary layer equations in order to include the rotational, viscous physics of transonic flows. The numerical optimization process searches for the best feasible design for the specified design objective and design constraints. The method is demonstrated with several examples at transonic flow conditions. Author

A91-53788*
A RETROSPECTIVE - COMPUTATIONAL AERODYNAMIC ANALYSIS METHODS APPLIED TO THE P-51 MUSTANG
 DAVID A. LEDNICER and IAN J. GILCHRIST (Analytical Methods, Inc., Redmond, WA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 688-700. refs (AIAA PAPER 91-3288) Copyright

The goals of this analysis were to learn the strengths and weaknesses inherent in the aerodynamics of the P-51. To enable such an analysis, models of the P-51B and P-51D Mustang have been prepared for use with the VSAERO linearized potential flow aerodynamic analysis method. Comparisons among computer

calculations, flight tests, and wind tunnel tests are presented. A discussion of general items of interest observed in the computational results is presented. Author

A91-53789* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NAVIER-STOKES SOLUTIONS ABOUT THE F/A-18 WING-LEX-FUSELAGE CONFIGURATION WITH MULTI-BLOCK STRUCTURED GRIDS
 FARHAD GHAFARI, JAMES M. LUCKRING, JAMES L. THOMAS (NASA, Langley Research Center, Hampton, VA), BRENT L. BATES (Vigyan, Inc., Hampton, VA), and ROBERT T. BIEDRON (Analytical Services and Materials, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 701-720. refs (Contract NAS1-18585; NAS1-19320) (AIAA PAPER 91-3291) Copyright

Three-dimensional thin-layer Navier-Stokes computations are presented for the F/A-18 configuration. The modeled configuration includes an accurate surface representation of the fuselage, leading-edge-extension, as well as the wing with and without leading-edge-flap deflection. A multi-block structured volume grid with various topologies is generated using transfinite interpolation technique. The flowfield domain is divided into twenty blocks, each representing a particular geometrical complexity of the configuration. The results are obtained from an algorithm for solving the compressible Navier-Stokes equations that incorporates an upwind-biased, flux-difference-splitting approach. In addition, a newly developed capability that allows for generalized surface patching among blocks is employed. Turbulent results are presented for flow conditions that correspond to recent NASA F/A-18 High Alpha Research Vehicle flight experiments. Good correlations between the computations and the flight test results are disclosed for both surface flow patterns as well as surface pressure distributions. Author

A91-53790* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERODYNAMIC ANALYSIS OF COMPLEX CONFIGURATIONS USING UNSTRUCTURED GRIDS
 NEAL T. FRINK (NASA, Langley Research Center, Hampton, VA), PARESH PARIKH, and SHAHYAR PIRZADEH (Vigyan, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 721-737. refs (AIAA PAPER 91-3292) Copyright

The purpose of this paper is to assess the accuracy and utility of a new unstructured, inviscid, upwind flow solver for the aerodynamic analysis of two aircraft configurations. The two configurations consist of a low-wing transport with nacelle/pylon on and off, and a generic high-speed civil transport. Computations are made at subsonic and transonic Mach numbers for the low-wing transport and at transonic and low-supersonic speeds for the high-speed civil transport. The results include an assessment of grid sensitivity and provide comparisons with experimental data. Author

A91-53791* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NUMERICAL SIMULATION OF A COMPLETE STOVL AIRCRAFT IN GROUND EFFECT
 MERRITT H. SMITH, KALPANA CHAWLA, and WILLIAM R. VAN DALSEM (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 738-748. refs (AIAA PAPER 91-3293) Copyright

The ability to accurately predict vehicle performance without resorting to full-scale tests will be critical to future powered-lift aircraft projects. This paper summarizes efforts to predict the flow field about a powered-lift aircraft, the YAV-8B Harrier, in low level

jet-borne flight by solution of the Reynolds-averaged Navier-Stokes equations. Results are compared with infrared images of the NASA YAV-8B Harrier V/STOL Systems Research Aircraft (VSRA) under similar flight conditions. Author

A91-53793*# Technion - Israel Inst. of Tech., Haifa.
ASYMMETRIC TURBULENT VORTICAL FLOWS OVER
SLENDER BODIES

DAVID DEGANI (Technion - Israel Institute of Technology, Haifa) and YUVAL LAVY (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 756-765. refs
 (Contract NCA2-578)
 (AIAA PAPER 91-3296) Copyright

Time-accurate numerical solutions have been obtained of equations modeling turbulent subsonic flows over a slender ogive-cylinder body of revolution in the high-angle-of-attack regime where a large asymmetry in the mean flow has been observed experimentally. A modified algebraic eddy-viscosity turbulence model was utilized to correctly compute the effects of the asymmetric vortices on the underlying viscous layers. In order to reproduce any one of the experimentally observed asymmetric flow-fields, it was found necessary to add a small geometrical disturbance near the body apex. By determining an appropriate size of the disturbance, it was possible to obtain excellent agreement between numerical results and experimental data for angles of attack of 30 and 40 deg, Reynolds numbers of 3.0×10 to the 6th and $= 4.0 \times 10$ to the 6th, and several roll angles. When the disturbance was removed, the flow field returned to its original symmetric shape. These results are similar in behavior to solutions obtained previously for laminar flows. Just as in the laminar case, results suggest that the origin of the asymmetry is a convective-type instability of an originally symmetric flow. Author

A91-53794#
CALCULATION OF MERGING TURBULENT WAKES AND
BOUNDARY LAYERS

AMIR MOGHADAM (Northrop University, Los Angeles, CA) and CHUNG-JEN TAM IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 766-776. refs
 (AIAA PAPER 91-3298) Copyright

The importance of the wake/boundary layer interaction to the design and optimization of high-lift multi-element airfoils has led many researchers to make detailed experimental and theoretical investigations of such flows. The present work was undertaken to develop a simple mathematical model for computation of merging turbulent wakes and boundary layers in two-dimensional flows at zero pressure gradient. An integral calculation method has been developed, and used to predict with reasonable success the mixing of an aerofoil wake with a flat plate boundary layer. Author

A91-53795#
IMPLICIT EQUILIBRIUM AND FINITE-RATE CHEMISTRY
MODELS FOR HIGH SPEED FLOW APPLICATIONS

M. MANI, R. H. BUSH, and P. G. VOGEL (McDonnell Aircraft Co., Saint Louis, MO) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 777-789. refs
 (AIAA PAPER 91-3299) Copyright

An upwind implicit characteristic base code has been developed that is applicable to all flow regimes from subsonic through hypersonic. Emphasis is placed on the high-speed extensions to the NASTD code which are applicable to the NASP and NASP derived vehicles. The diagonalization of the gasdynamic matrices is generalized to be applicable to ideal gas and multispecies flow. The generalized CFD code NASTD is extended to include the effects of various chemistry models. L.M.

A91-53796#

THE SIMULATION AND CORRECTION OF WIND TUNNEL
WALL INTERFERENCE ON DELTA WING LIFT USING
NAVIER-STOKES AND EULER SOLUTIONS

JEFFREY P. THOMAS and C. E. LAN (Kansas, University, Lawrence) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 790-802. refs
 (AIAA PAPER 91-3300) Copyright

A computational method for predicting, assessing, and correcting solid wall wind tunnel interference effects on delta wing lift at low subsonic speeds and high angles-of-attack is presented. First, a mesh system representing the domain of a delta wing model in a wind tunnel is generated and used along with appropriate boundary conditions and a thin-layer Navier-Stokes solver for a flowfield simulation of the wind tunnel environment. The computed tunnel wall pressure signature is then used as boundary data for a Euler solution of the same wind tunnel domain without the delta wing model. This yields a 'correction flowfield' which may be used to estimate values for Delta-alpha and Delta-q needed in correcting total model forces to free-air conditions. Comparing with experimental data for a 76-deg delta wing model tested in a small wind tunnel, calculations show that interference effects on total lift characteristics can be predicted and further corrected using the computed pressure signature and 'correction flowfield' information. Author

A91-53797#

GENERIC SUPERSONIC AND HYPERSONIC
CONFIGURATIONS

H. SOBIECZKY (DLR, Goettingen, Federal Republic of Germany) and J. C. STROEVE IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 803-809. Research supported by DLR and University of Colorado. refs
 (AIAA PAPER 91-3301) Copyright

A geometry generator for preliminary aerodynamic design, parametric optimization and the preprocessing of CFD boundary conditions is presented. With emphasis on supersonic aircraft components, ranging from waverider caret wings to generic lifting bodies derived from recent aerospace research projects, the simple mathematical basis and its consequent use throughout various applications is illustrated. Author

A91-53798*# West Virginia Univ., Morgantown.

WINGLET EFFECTIVENESS ON LOW ASPECT RATIO WINGS
AT SUPERSONIC MACH NUMBERS

J. A. KEENAN and J. M. KUHLMAN (West Virginia University, Morgantown) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 810-818. refs
 (Contract NAG1-951)
 (AIAA PAPER 91-3305) Copyright

A computational study has been conducted on two wings of aspect ratios 1.244 and 1.865, each having 65-deg leading edge sweep angles, to determine the effects of nonplanar winglets at supersonic Mach numbers. A design Mach number of 1.62 was selected. The winglets studied were parametrically varied in alignment, length, sweep, camber, and thickness to determine the effects of winglet geometry on predicted performance. For the computational analysis, an existing Euler code that employed a marching technique was used. The results indicated that the possibility existed for wing-winglet geometries to equal the performance of wing-alone bodies in supersonic flows with both bodies having the same semispan length. The performance parameters of main interest were the lift-to-pressure drag ratio and the pressure drag coefficient as functions of lift coefficient. The lift coefficient range for this study was from -0.20 to 0.70 with emphasis on the range of 0.10 to 0.22. Author

A91-53799#

APPLICATION OF EULER EQUATIONS TO COMPUTATION OF VORTEX FLOW ON WING-BODY AND CLOSE-COUPLED WING-BODY-CANARD CONFIGURATIONS

E. MALFA, L. GUARINO, and L. VISINTINI (Aermacchi S.p.A., Varese, Italy) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 819-829. Research supported by Ministero della Difesa of Italy. refs

(AIAA PAPER 91-3306) Copyright

The vortical flowfield around a 65-deg sharp-edged cropped delta wing/body and a close-coupled wing/body/canard configuration was computed through the numerical solution of the compressible Euler equations. The purpose of the present investigation is to verify capabilities and limitations inherent in Euler methods to simulate vortex flows around a generic fighter-like configuration. Test calculations with various combinations of grid topologies and grid densities were carried out around the wing/body configuration in a subsonic and in a transonic flow condition. For vortical flows an efficient grid structure was generated and tested. Around the canard-on configuration, results in the same transonic flow condition were also obtained. The interaction between the canard vortex system and the wing flowfield was studied. Author

A91-53800#

AN EXPERIMENTAL INVESTIGATION OF THE TURBULENCE EFFECT OF A LEADING WING ON A TRAILING AIRCRAFT

IBRAHIM A. OLWI and MOHAMMAD A. GHAZI (King Abdulaziz University, Jeddah, Saudi Arabia) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 830-837. Research supported by King Abdulaziz University. refs

(AIAA PAPER 91-3309) Copyright

Wind tunnel tests that were conducted to study the effect of trailing vortices due to a large leading wing on a trailing aircraft. The aerodynamic response of the trailing aircraft is examined through measurements of lift, drag, and pitching moment. Results are presented for various angles of attack of the leading wing and of the trailing aircraft. Additionally, the effect of the leading wing location with respect to the aircraft model is scrutinized. It is shown that trailing vortices cause remarkable reductions in lift on trailing aircraft. This phenomenon becomes more significant as the angle of attack of the leading object is increased. Results demonstrate that in order to maintain the same lift, the drag increases as the leading wing angle of attack is increased. The aircraft stability analysis indicates that the leading wing angle of attack has a slight effect on the stability margin. Author

A91-53801#

APPLICATION OF AN EULER-EQUATION METHOD TO A SHARP-EDGED DELTA-WING CONFIGURATION WITH VORTEX FLOW

H. W. M. HOEIJMAKERS and J. I. VAN DEN BERG (National Aerospace Laboratory, Amsterdam, Netherlands) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 838-850. Research supported by Netherlands Agency for Aerospace Programs. refs

(AIAA PAPER 91-3310) Copyright

The flow about a wing-body-sting configuration with a 65-deg sharp-edged cropped delta wing and an under-wing body is simulated by solving the Euler equations. Results are presented for the configuration at a Mach number of 0.85 and at incidences ranging from 10 to 20 deg. For this transonic free-stream Mach number a strong leading-edge vortex as well as shocks develop in the flowfield above the wing. For the wing-body-sting configuration the numerical solution is investigated in detail and computational results are compared with experimental data. The investigation includes the analysis of the complex flow pattern in the near wake. The influence of the under-wing body on the flowfield about the wing is assessed by comparing the solution

for the complete configuration with the solution obtained for the wing alone on a grid similar to that for the wing-body-sting configuration. Author

A91-53802*# Old Dominion Univ., Norfolk, VA.

SUPERSONIC QUASI-AXISYMMETRIC VORTEX BREAKDOWN

OSAMA A. KANDIL, HAMDY A. KANDIL (Old Dominion University, Norfolk, VA), and C. H. LIU (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 851-863. refs

(Contract NAG1-994)

(AIAA PAPER 91-3311) Copyright

An extensive computational study of supersonic quasi-axisymmetric vortex breakdown in a configured circular duct is presented. The unsteady, compressible, full Navier-Stokes (NS) equations are used for the present computational study. The NS equations are solved for quasi-axisymmetric flow using an implicit, upwind, flux-difference splitting, finite-volume scheme. The quasi-axisymmetric solutions are time accurate and are obtained by forcing the components of the flowfield vector to be equal on two axial planes, which are in close proximity of each other. The computational study addresses the effect of the Reynolds number, for laminar flows, on the evolution and persistence of vortex breakdown. The effect of boundary conditions at the duct exit on vortex breakdown is also studied. Finally, the effect of swirl ratio at the duct inlet is investigated. Author

A91-53803#

WAKE ROLL-UP ANALYSIS USING A THREE-DIMENSIONAL VORTEX-IN-CELL METHOD

I. KROO (Stanford University, CA) and R. RIBEIRO IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 864-874. refs

(AIAA PAPER 91-3312) Copyright

This paper describes the application of a vortex-in-cell method to the computation of three-dimensional wakes generated by lifting-surfaces. Wings are represented by a vortex-lattice model, and wakes by line-vortices. The method distributes the vorticity concentrated in the vortex-segments onto a Cartesian grid, using quadratic-spline spreading functions. The velocities at grid points are obtained using a simple Poisson solver. Velocities anywhere in the grid can be computed through interpolation. The vortex-in-cell scheme is used in a steady-wake relaxation scheme, as well as in a correction procedure for circulation values. Test cases are presented to discuss the character of the effective viscous core introduced by the vortex-in-cell model, and its interaction with the vortex-lattice representation. A case with close interaction between wake and wing is presented and compared with experiment. Very good agreement is obtained without any special adjustments to avoid proximity between vortex and wing. Author

A91-53805#

STATIC AEROELASTIC EFFECTS UPON WING SPAN LOADS

L. V. SCHMIDT (U.S. Naval Postgraduate School, Monterey, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 884-891. refs

(AIAA PAPER 91-3316)

The purpose of this paper is to provide an overview of first principles of static aeroelasticity as they influence the interaction of structural deformations upon wing span loadings. It may be shown that fairly simple lifting surface and structure models can realistically illustrate a significant amount of aerodynamic concepts for the engineering student. Insights gained by this outlook lead to an awareness of the limitations of physical modeling as well as provide a recognition that more advanced solution methods are needed to accommodate configuration specific influences, such as low aspect and taper ratios, and highly swept wings (slender deltas) when mounted upon realistic configuration shapes. Study

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results illustrate the influence of subsonic Mach number, sweepback and elastic axis location upon wing aerodynamic behavior. Author

A91-53807#

PREDICTIONS AND MEASUREMENTS OF INTERNAL AND EXTERNAL FLOW FIELDS OF A GENERIC HYPERSONIC INLET

E. J. MARQUART (Calspan Engineering Development Center, Arnold AFB, TN) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 900-909. refs (AIAA PAPER 91-3320)

A hypersonic wind tunnel test was conducted at the Arnold Engineering Development Center on a 2D generic hypersonic inlet for a variety of ramp angles, contraction ratios, cowl locations, injected mass flow amounts, and back-pressures. This paper describes the wind tunnel test techniques used and presents comparisons of representative data to estimates from simple theory. It is shown that 2D theory describes well (within + or - 5 percent) the external boundary-layer heights on the centerline about 1.5 in. upstream of the cowl lip. One-dimensional theory describes fairly well (+ or - 5 percent, except at the throat) the surface properties of the internal flow field. L.M.

A91-53808*# Ohio State Univ., Columbus.

PRESSURE AND TEMPERATURE FLUCTUATIONS IN AN AXISYMMETRIC FLOWFIELD DUE TO SHOCK-BOUNDARY LAYER INTERACTIONS AT HIGH REYNOLDS NUMBERS AT MACH 6

M. J. FLANAGAN, JR. (Ohio State University, Columbus) and J. HAYES (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 910-918. Research supported by NASA. refs (AIAA PAPER 91-3321) Copyright

Pressure and temperature fluctuations have been measured in the vicinity of shock wave-boundary layer interactions due to conical compression ramps on an axisymmetric body. The basic model is a cylindrical body with a 10-deg conical nose. Four conical ramps of vertex angles, 20, 25, 30, and 35 deg serve as shock wave generators. Surface temperature and pressure surveys have been made in the vicinity of the conical ramp vertex, the separation point, and the reattachment point. The temperature response within the flowfield appears to be steady-state for all compression ramp angles and all Reynolds numbers. The pressure response shows some oscillations in the vicinity of the separation point. The characteristic frequency of these fluctuations appears to be in the range from 200 to 1200 Hz with most of the power near 400 Hz. These data indicate the flowfield to be steady-state for all locations with the exception of localized pressure fluctuations in the vicinity of the separation point. Author

A91-53810#

NONEQUILIBRIUM EFFECTS ON THE AERODYNAMIC HEATING OF LIFTING HYPERSONIC VEHICLES

GEORGE R. INGER (Iowa State University of Science and Technology, Ames) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 934-944. refs (AIAA PAPER 91-3324) Copyright

The aerodynamic heating aspect of a generic lifting hypersonic vehicle configuration is examined in the high altitude hypersonic flight regime when nonequilibrium dissociation/recombination in the flow field and finite surface catalysis effects are both important. Analyses of these effects are given for three important heating regions: the nose, the swept wing leading edge attachment line, and the windward body centerline. Moreover, closed form relationships for the relative nonequilibrium effects are developed

for each region that enable both computer code-prediction validation and cost-effective parametric engineering studies. Author

A91-53811#

A THREE-DIMENSIONAL INVERSE METHOD FOR SUPERSONIC AND HYPERSONIC BODY DESIGN

W. H. MASON (Virginia Polytechnic Institute and State University, Blacksburg) and JAEWOO LEE IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 945-954. refs (AIAA PAPER 91-3325) Copyright

An inverse method for fully three-dimensional supersonic and hypersonic bodies is developed using the Euler equations. The method is designed to be easily incorporated into existing analysis codes, and provides the aerodynamic designer with a powerful tool for design of aerodynamic shapes of arbitrary cross section. These shapes can correspond to either 'wing like' pressure distributions or to 'body like' pressure distributions. Examples are presented illustrating the method for a non-axisymmetric fuselage type pressure distribution and a cambered wing type application. The method performs equally well for both nonlifting and lifting cases. Author

A91-53814*# Douglas Aircraft Co., Inc., Long Beach, CA. **MULTI-ELEMENT AIRFOIL OPTIMIZATION FOR MAXIMUM LIFT AT HIGH REYNOLDS NUMBERS**

WALTER O. VALAREZO, CHET J. DOMINIK (Douglas Aircraft Co., Long Beach, CA), ROBERT J. MCGHEE, WESLEY L. GOODMAN, and KEITH B. PASCHAL (NASA, Langley Research Center, Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 969-976. refs (AIAA PAPER 91-3332) Copyright

An experimental study has been performed to assess the maximum lift capability of a supercritical multielement airfoil representative of an advanced transport aircraft wing. The airfoil model was designed with a leading-edge slat and single or two-segment trailing-edge flaps. Optimization work was performed at various slat/flap deflections as well as gap/overhang positions. Landing configurations and the attainment of maximum lift coefficients of 4.5 with single-element flaps and 5.0 with two-segment flaps was emphasized. Test results showed a relatively linear variation of the optimum gap/overhang positioning of the slat versus slat deflection, considerable differences in optimum rigging between single and double segment flaps, and large Reynolds number effects on multielement airfoil optimization. R.E.P.

A91-53815*# Pennsylvania State Univ., University Park.

GENERALIZED MULTI-POINT INVERSE AIRFOIL DESIGN

MICHAEL S. SELIG and MARK D. MAUGHMER (Pennsylvania State University, University Park) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 977-986. refs (Contract NGT-50341)

(AIAA PAPER 91-3333) Copyright

In a rather general sense, inverse airfoil design can be taken to mean the problem of specifying a desired set of airfoil characteristics, such as the airfoil maximum thickness ratio, pitching moment, part of the velocity distribution or boundary-layer development, etc., then from this information determine the corresponding airfoil shape. This paper presents a method which approaches the design problem from this perspective. In particular, the airfoil is divided into segments along which, together with the design conditions, either the velocity distribution or boundary-layer development may be prescribed. In addition to these local desired distributions, single parameters like the airfoil thickness can be specified. The problem of finding the airfoil shape is determined by coupling an incompressible, inviscid, inverse airfoil design

method with a direct integral boundary-layer analysis method and solving the resulting nonlinear equations via a multidimensional Newton iteration technique. The approach is fast and easily allows for interactive design. It is also flexible and could be adapted to solving compressible, inverse airfoil design problems. Author

A91-53816#

TRANSONIC AIRFOIL ANALYSIS BY EXPLICIT TVD FORMULATIONS OF THE NAVIER-STOKES EQUATIONS

S. REDDY, MICHAEL PAPADAKIS, and X. LIU (Wichita State University, KS) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 987-998. refs (AIAA PAPER 91-3334) Copyright

Explicit Non-MUSCL upwind and symmetric Total Variation Diminishing (TVD) schemes are applied to solve the Navier-Stokes equations for two-dimensional airfoils in transonic flow. The finite difference explicit MacCormack and the four step second order Runge-Kutta schemes are used to advance the solution in time. Turbulence properties are calculated with the algebraic Baldwin-Lomax and with the one equation Baldwin-Barth turbulence models. Comparisons of experimental and computational results for a RAE-2822 airfoil section are presented. In general, good agreement between analysis and experimental results is demonstrated. The TVD schemes used show good shock capturing properties for all cases presented. Author

A91-53817*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

CALCULATION OF UNSTEADY AIRFOIL LOADS WITH AND WITHOUT FLAP DEFLECTION AT -90 DEGREES INCIDENCE

PAUL M. STREMEL (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1010-1024. refs (AIAA PAPER 91-3336) Copyright

A method has been developed for calculating the viscous flow about airfoils with and without deflected flaps at -90 deg incidence. This unique method provides for the direct solution of the incompressible Navier-Stokes equations by means of a fully coupled implicit technique. The solution is calculated on a body-fitted computational mesh incorporating a staggered grid method. The vorticity is determined at the node points, and the velocity components are defined at the mesh-cell sides. The staggered-grid orientation provides for accurate representation of vorticity at the node points and for the conservation of mass at the mesh-cell centers. The method provides for the direct solution of the flow field and satisfies the conservation of mass to machine zero at each time-step. The results of the present analysis and experimental results obtained for a XV-15 airfoil are compared. The comparisons indicate that the calculated drag reduction caused by flap deflection and the calculated average surface pressure are in excellent agreement with the measured results. Comparisons of the numerical results of the present method for several airfoils demonstrate the significant influence of airfoil curvature and flap deflection on the predicted download. Author

A91-53823*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

A COMPUTATIONAL STUDY OF THE F-5A FOREBODY EMPHASIZING DIRECTIONAL STABILITY

WILLIAM H. MASON and R. RAVI (Virginia Polytechnic Institute and State University, Blacksburg) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1071-1081. refs (Contract NAG1-1037) (AIAA PAPER 91-3289) Copyright

CFD has been used to study the F-5A forebody flowfield at high angle-of-attack combined with sideslip. The classic wind tunnel experiment demonstrating the dominant contribution of the F-5A

forebody to directional stability at high angle-of-attack has been simulated computationally over an angle-of-attack range from 10 deg to 45 deg. The key wind tunnel trend for $C_{n\beta}$ was obtained computationally using the code known as cfl3d to solve the Reynolds' equations using a modified form of the Baldwin-Lomax turbulence model. The computations provide detailed and fascinating insights into the physics of flowfield. The results of the investigation show that CFD has reached a level of development where computational methods can be used for high angle-of-attack aerodynamic design. Author

A91-53829* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

COMPRESSIBLE EQUILIBRIUM TURBULENT BOUNDARY LAYERS AT NONADIABATIC WALL CONDITIONS

CINDY W. ALBERTSON (NASA, Langley Research Center, Hampton, VA) and ROBERT L. ASH (Old Dominion University, Norfolk, VA) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1573-1580. Previously cited in issue 16, p. 2477, Accession no. A90-37948. refs Copyright

A91-53830

CONTROL OF VORTEX-SYSTEM STABILITY

A. SEGNER (Technion - Israel Institute of Technology, Haifa) and Z. RUSAK AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1581-1588. refs Copyright

The present analytical concept for vortex-system stability control is based on a general theory for three-dimensional long wave linear stability of straight vortex filaments which are immersed in potential flowfields. Criteria are developed for analyzing the theoretical possibility of analyzing vortex-system stability, and a novel active-control concept is formulated for open- or closed-loop feedback mode vortex-stability control. Two illustrative examples demonstrate the efficacy of the combined theories of vortex stability and control, and control laws based on the measurement of vortex disturbances are proposed for either suppression or amplification of the Crow instability of a vortex near a straight plane. O.C.

A91-53835

LOCALLY IMPLICIT TOTAL-VARIATION-DIMINISHING SCHEMES ON UNSTRUCTURED TRIANGULAR MESHES

C. J. HWANG (National Cheng Kung University, Tainan, Republic of China) and J. L. LIU AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1619-1626. refs Copyright

A numerical solution procedure that includes locally implicit total-variation-diminishing schemes and adaptive mesh generation techniques has been developed in this work. In a Cartesian coordinate system, the Euler equations are solved by using a cell-centered finite volume algorithm. A new construction of symmetric total-variation-diminishing schemes on unstructured triangular meshes is presented. The validation of the present solution-adaptive methods is confirmed by comparison with related numerical results for inviscid flows around an isolated NACA 0012 airfoil and passing through a channel with a circular arc bump in transonic and supersonic flow regimes. To further prove the feasibility of this approach, a two-element airfoil flow is also investigated. Furthermore, one unsteady transonic channel flow is studied to demonstrate the reliability and capability of the present solution procedure for a time accurate calculation. Author

A91-53838* Pennsylvania State Univ., University Park.

SKIN-FRICTION MEASUREMENTS AND COMPUTATIONAL COMPARISON OF SWEEP SHOCK/BOUNDARY-LAYER INTERACTIONS

K.-S. KIM, Y. LEE, F. S. ALVI, G. S. SETTLES (Pennsylvania State University, University Park), and C. C. HORSTMAN (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1643-1650. Previously cited in issue 08, p. 1102, Accession no. A90-22209. refs

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A91-53839

EFFECT OF PERIODIC BLOWING ON ATTACHED AND SEPARATED SUPERSONIC TURBULENT BOUNDARY LAYERS

MICHAEL S. SELIG (Pennsylvania State University, University Park) and ALEXANDER J. SMITS (Princeton University, NJ) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1651-1658. refs
(Contract DAAG29-85-K-0255)
Copyright

Two periodic-blowing experiments have been conducted with a view to the control of unsteadiness in two-dimensional shock-wave/turbulent boundary-layer interactions. While in the first experiment the blowing through a spanwise slot produced an unsteady shock wave/boundary-layer interaction boundary layer, the second introduced the periodic blowing into the shock-induced separation bubble formed by a 24-deg compression-corner interaction. The results obtained suggest that the naturally unsteady shock motion in the compression-ramp interaction does not significantly contribute to turbulence amplification, as had been supposed; instead, large-scale motions are responsible for the observed mixing. O.C.

A91-53841* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

STREAMWISE UPWIND ALGORITHM FOR COMPUTING

UNSTEADY TRANSONIC FLOWS PAST OSCILLATING WINGS

SHIGERU OBAYASHI, GURU P. GURUSWAMY, and PETER M. GOORJIAN (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1668-1677. Previously cited in issue 21, p. 3290, Accession no. A90-45915. refs

Copyright

A91-53854#

AN EXPERIMENTAL STUDY OF DOUBLE DELTA WINGS IN SIDESLIP

D. S. GRISMER, R. C. NELSON (Notre Dame, University, IN), and W. L. ELY (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 13 p. Research supported by McDonnell Aircraft Co. and University of Notre Dame. refs
(AIAA PAPER 91-3308) Copyright

The results of an experimental investigation of the influence of sideslip on the aerodynamic performance of two strake/wing platforms is presented. The strake sweep, wing sweep and strake-to-wing fineness ratio for the two models were 80 deg/40 deg/0.6 and 80 deg/60 deg/0.6, respectively. Flow visualization data was obtained by marking the strake and wing vortices with smoke so that the state of the vortices (i.e., existence, pre or postbreakdown state) and the trajectories could be measured. Surface pressure measurements were taken on the strake and wing upper surfaces. These measurements were used in combination with the visualization data to determine the effect of sideslip on the flowfield and upper surface pressure distributions. The vortical flow and corresponding pressure field was found to be very sensitive to sideslip at moderate angles of attack. For large angles of attack the flowfield and pressure field exhibited static hysteresis with respect to sideslip. Author

A91-53862* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

LOW-SPEED AERODYNAMICS OF THE TRAILED-ROTOR HIGH-SPEED ROTORCRAFT CONCEPT IN CRUISE CONFIGURATION

JEFFREY L. JOHNSON, STEPHEN M. SWANSON (NASA, Ames Research Center; Sterling Software, Inc., Moffett Field, CA), KEN W. SAMBELL (V/STOL Aircraft Research Associates, Mesa, AZ), RAY SUNDAR (McDonnell Douglas Helicopter Co., Mesa, AZ), and LISA COWLES (U.S. Navy, Naval Air Development Center,

Warminster, PA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 21 p. refs
(AIAA PAPER 91-3230) Copyright

An experimental investigation was performed to determine the low-speed aerodynamic performance characteristics of the trailed-rotor high-speed rotorcraft concept in its cruise configuration. A 15 percent scale semispan model was tested at speeds up to 180 knots in the NASA Ames 7-by 10-Foot Subsonic Wind Tunnel. The objective of this investigation was to determine specific aerodynamic performance characteristics to assist in evaluating the trailed rotor as a high-speed rotorcraft. The aerodynamic influence of the following model configuration changes were determined: ailerons, flaps, wing/pod angle, number of trailed blades, trailed-blade twist and azimuth, and wing/pod fillet radius. The low-speed performance objectives for the concept were met and results indicated that the trailed-rotor model had no significant adverse aerodynamic characteristics. The optimum low-speed cruise configuration was determined. Results suggest the trailed-rotor concept has better low-speed cruise performance characteristics than the folding tiltrotor configuration. Author

A91-53863*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ANALYSIS OF FLIGHT-MEASURED BOUNDARY-LAYER STABILITY AND TRANSITION DATA

CLIFFORD J. OBARA, CYNTHIA C. LEE (NASA, Langley Research Center, Hampton, VA), and PAUL M. H. W. VIJGEN (High Technology Corp., Hampton, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 16 p. refs
(Contract NAS1-18420)
(AIAA PAPER 91-3282) Copyright

The paper concentrates on the computational analysis of both the Tollmien-Schlichting and crossflow-type instabilities using the results of a boundary-layer transition flight experiment on a smooth swept test surface. In addition, the effect of nonadiabatic wall conditions is analyzed using the measured surface temperature distribution on the boundary-layer development and stability growth. The computational methods utilized in analyzing the boundary-layer stability characteristics are discussed: one approach analyzes the Tollmien-Schlichting and crossflow instabilities independently with maximum Tollmien-Schlichting n -factors near nine and maximum crossflow n -factors near six at transition onset for separate cases, while the second approach analyzes the instabilities for maximum growth regardless of the type. As much as a 27-percent increase in n -factor is found at transition onset due to an increased Tollmien-Schlichting instability. V.T.

A91-53865*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC CHARACTERISTICS OF THE HL-20 AND HL-20A LIFTING-BODY CONFIGURATIONS

GEORGE M. WARE, BERNARD SPENCER, JR., and JOHN R. MICOL (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 21 p. refs
(AIAA PAPER 91-3215)

The data show that the HL-20 is longitudinally and laterally stable over the test range from Mach 10 to 0.2. At hypersonic speeds it has a trimmed lift/drag ratio of 1.4. This value gives the vehicle a cross range capability similar to that of the Space Shuttle. At subsonic speeds, the HL-20 has a trimmed lift/drag ratio of about 3.6. Replacing the flat plate outboard fins with fins having an airfoil shape, increased the maximum trimmed L/D to 4.3. Preliminary evaluation of configuration modifications (the HL-20A series), indicates that trim at higher values of lift at hypersonic speeds could be achieved with an L/D of about 1.0. In the supersonic range, the lift and directional stability characteristics were improved. The untrimmed subsonic L/D was increased to 5.8 with airfoil fins. Author

A91-53867#

INFLUENCE OF FOREBODY CROSS-SECTION SHAPE ON VORTEX FLOWFIELD STRUCTURE AT HIGH ALPHA

J. T. KEGELMAN and F. W. ROOS (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (Contract N00019-88-C-0357) (AIAA PAPER 91-3250) Copyright

A comprehensive series of experiments has been conducted to determine the quantitative structure of the vortical flowfields about three generic forebody shapes at high angles of attack. Detailed insight is provided into the asymmetric liftoff and bursting of the vortices generated by the bodies. As asymmetric flow develops the detaching vortex is initially stronger than the vortex that remains attached. However, the detached vortex loses strength with increasing axial distance and with increasing α (angle of attack) whereas the attached vortex grows in strength unless and until it bursts. If the separation is turbulent, the attached vortex is weaker than for laminar separation. Vortices are stronger at any α for the elliptical body than for the circular tangent ogive. The strongest vortices of all are generated by the chined forebody. These vortices show burst behavior similar to those over a delta wing. Author

A91-53868#

UNSTEADY AERODYNAMICS OF RAPIDLY PITCHED FLAT PLATE WINGS

C. M. WANG, J. C. WU, and P. QIAN (Georgia Institute of Technology, Atlanta) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 11 p. Research supported by U.S. Army. refs (AIAA PAPER 91-3262) Copyright

A very efficient two-dimensional zonal procedure, based on the velocity-vorticity formulation, is generalized to treat three-dimensional general viscous flow problems. The three non-zero vorticity components in a three-dimensional flow problem satisfy the vorticity divergence-free condition through a numerical filter mechanism. Flows around fast pitched flat plate wings are computed by the generalized zonal procedure. Author

A91-53870*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

REYNOLDS NUMBER EFFECTS ON SUPERSONIC ASYMMETRICAL FLOWS OVER A CONE AT HIGH ANGLE OF ATTACK

J. L. THOMAS (NASA, Langley Research Center, Hampton, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3295) Copyright

The supersonic viscous flow over a 5-degree half-angle cone at an angle of attack of four times the cone half-angle is studied computationally using both the conical and the three-dimensional Navier-Stokes equations. The numerical solutions were obtained with an implicit, upwind-biased algorithm. Asymmetrical flowfields of the absolute-instability type are found using the conical-flow equations which agree with published results. However, the absolute instabilities of the originally symmetric flow found with the conical equations do not occur in the three-dimensional simulations, although spurious asymmetric three-dimensional flows for symmetric bodies arise if the grid resolution is insufficient in the nose region. The asymmetric flows computed with the three-dimensional equations are convective instabilities and are possible if the local Reynolds number exceeds a critical value and a fixed geometric asymmetry is imposed. A continuous range of asymmetries can be developed, depending on the size of the disturbance and the Reynolds number. As the Reynolds number is increased, the asymmetries demonstrate a bistable behavior at levels of side force consistent with those predicted using the conical equations. Below a certain critical Reynolds number, any flow asymmetries arising from a geometrical asymmetry are damped with increasing distance downstream from the geometrical asymmetry. Author

A91-53872*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN ASSESSMENT OF CURRENT METHODS FOR DRAG-DUE-TO-LIFT MINIMIZATION AT SUPERSONIC SPEEDS
MICHAEL J. MANN (NASA, Langley Research Center, Hampton, VA) and HARRY W. CARLSON (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 20 p. refs (AIAA PAPER 91-3302) Copyright

The estimation and minimization of drag-due-to-lift at supersonic speeds has been examined in this study. Correlations of theory with experimental data are used to assess the applicability and limitations of the linearized theory. The role of leading-edge thrust and the use of twist and camber to develop distributed thrust are also discussed. A semiempirical design and estimation method which takes into account the shortcomings of the linear theory is presented. The use of this method will allow the design of more nearly optimum lifting surfaces and provide an accurate prediction of their level of performance. A preliminary examination is made of the use of an Euler code for estimation of the aerodynamic characteristics of a twisted and cambered wing. Author

A91-53873*# MCAT Inst., San Jose, CA.

REATTACHMENT STUDIES OF AN OSCILLATING AIRFOIL DYNAMIC STALL FLOW FIELD

S. AHMED (MCAT Institute, San Jose, CA) and M. S. CHANDRASEKHARA (NASA, Ames Research Center, Moffett Field; U.S. Navy-NASA, Joint Institute of Aeronautics; U.S. Naval Postgraduate School, Monterey, CA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 13 p. Research supported by U.S. Army and USAF. refs (AIAA PAPER 91-3225)

The reattaching flow over an oscillating airfoil executing large amplitude sinusoidal motion around a mean angle of attack of 10 degrees has been studied using the techniques of stroboscopic schlieren, two component laser Doppler velocimetry and point diffraction interferometry, for a free stream Mach number of 0.3 and a reduced frequency of 0.05. The results show that the dynamically stalled flow reattaches in a process that begins when the airfoil is very close to the static stall angle on its downward stroke and progresses over the airfoil through a large range of angles of attack as the airfoil decreases to about 6 degrees. The airfoil suction peak shows a dramatic rise as the static stall angle is approached and the velocity profiles develop such that the flow near the surface is accelerated. The process completes through the disappearance of a separation bubble that forms over the airfoil. Author

A91-53874#

ROLL-INDUCED CROSS-LOADS ON A DELTA WING AT HIGH INCIDENCE

E. S. HANFF and X. Z. HUANG (National Research Council of Canada, Institute for Aerospace Research, Ottawa) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 13 p. refs (AIAA PAPER 91-3223) Copyright

Wind-tunnel experiments conducted on a 65 deg delta wing subjected to large-amplitude high-rate oscillations in roll have revealed the presence of nonlinear, time dependent loads in the longitudinal plane. Correlations between these loads with surface pressure measurements as well as high-speed flow visualization results indicate that the instantaneous loads are largely determined by the corresponding position of the leading edge vortex breakdown points. Author

A91-53876*# Lockheed Engineering and Sciences Co., Hampton, VA.

A PRELIMINARY INVESTIGATION OF INLET UNSTART EFFECTS ON A HIGH-SPEED CIVIL TRANSPORT CONCEPT
CHRISTOPHER S. DOMACK (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 11 p. refs

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(Contract NAS1-19000)

(AIAA PAPER 91-3327) Copyright

Vehicle motions resulting from a supersonic mixed-compression inlet unstart were examined to determine if the unstart constituted a hazard severe enough to warrant rejection of mixed-compression inlets on high-speed civil transport (HSCT) concepts. A simple kinematic analysis of an inlet unstart during cruise was performed for a Mach 2, 4, 250-passenger HSCT concept using data from a wind-tunnel test of a representative configuration with unstarted inlets simulated. A survey of previously published research on inlet unstart effects, including simulation and flight test data for the YF-12, XB-70, and Concorde aircraft, was conducted to validate the calculated results. It was concluded that, when countered by suitable automatic propulsion and flight control systems, the vehicle dynamics induced by an inlet unstart are not severe enough to preclude the use of mixed-compression inlets on an HSCT from a passenger safety standpoint. The ability to provide suitable automatic controls appears to be within the current state of the art. However, the passenger startle and discomfort caused by the noise, vibration, and cabin motions associated with an inlet unstart remain a concern. Author

A91-53877#

COMPUTATIONS OF THE SUPERSONIC FLOW OVER AN HSCT TYPE CONFIGURATION AND COMPARISON WITH WIND TUNNEL DATA

G. A. BLOM, D. N. BALL, J. E. BUSSOLETTI, and N. J. YU (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 10 p. refs

(AIAA PAPER 91-3290) Copyright

CFD has recently begun to be applied in the design environment in association with a technique for conducting parametric variations in trade studies. Attention is presently given to the illustrative force and moment test-theory comparisons for several CFD methods using linear theory, full or exact potential, Euler, and parabolized thin-layer Navier-Stokes solutions; these results are compared with wind tunnel test data for a High Speed Civil Transport wing-body configuration. Each of the higher-order CFD analysis methods used in analyzing this configuration was able to furnish improved predictions of forces and moments, when compared to linear theory. O.C.

A91-53878#

EXPERIMENTAL AND NUMERICAL ANALYSIS ON VENTILATED AIRFOILS

YASUHIRO TANI, KOHEI TANAKA, YASUHIRO KOSHIOKA, NASHAKI NAKADATE, KEISUKE KAMO (Fuji Heavy Industries, Ltd., Utsunomiya, Japan), and KANICHI AMANO (Japan Aircraft Development Corp., Tokyo) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3335) Copyright

Wind tunnel tests and Navier-Stokes analyses are carried out on the transonic airfoils with the passive ventilation mechanisms according to the new concept for drag reduction. It consists of a pair of slits connected by an internal channel, so the passive ventilation is established by the pressure difference between them. The location of the blowing slit is near the leading edge on the upper surface, and that of suction slit is near the trailing edge on the upper surface or near the leading edge on the lower surface. Experiments show that the frictional drag reduction and the suppression of the boundary layer separation provide the lift-drag ratio improvement. Author

A91-53880#

TRANSONIC LOW REYNOLDS NUMBER AIRFOILS

MARK DRELA (MIT, Cambridge, MA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 11 p. Research supported by MIT and NSF. refs (AIAA PAPER 91-3337) Copyright

The performance and behavior of airfoils designed for operation in the transonic low Reynolds-number regime are investigated along with sensitivities to operating parameters and airfoil thickness. A

computational analysis indicates that 35-km ceiling performance at $M = 0.60$ and $Re = 200,000$ depends on the effective use of the transonic flow to enhance transition and reduce separation-bubble losses; the separation bubbles become associated with large lambda shock structures at the highest tolerable Mach numbers. Airfoil-performance predictions are parameterized by quantities dependent on altitude and vehicle characteristics only, and independent of flight trim conditions. It is noted that variations in airfoil thickness between 11 to 15 percent have little impact on aerodynamic performance. V.T.

A91-53881#

ANALYSIS OF NON-PLANAR WINGS WITH CONSTRAINED-SPAN DESIGN APPLICATIONS

ERIC R. DICKEY (Douglas Aircraft Co., Long Beach, CA) and KENNETH R. SIVIER (Illinois University, Urbana) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs

(AIAA PAPER 91-3317) Copyright

The deflected streamtube, lifting arc, and lifting surface numerical techniques for conceptual or early preliminary evaluation of nonplanar lifting systems are reviewed. A correlation with low-speed wind tunnel test data of a channel wing is done to determine the relative accuracy of the methods for predicting the aerodynamic coefficients of nonplanar wings. The analysis of a semicircular arc wing shows that, on a fixed-span basis, it represents an interesting wing configuration alternative. The results of a wing configuration trade study, for aircraft, in cruise configuration, are presented. The results illustrate the advantages of the arc wing for this type of aircraft where span constraint is a major design factor. Author

A91-53884#

APPLICATION OF OSWALDITCH'S THEOREM TO SUPERCritical AIRFOIL DRAG CALCULATION

G. R. INGER (Iowa State University of Science and Technology, Ames) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 9 p. refs

(AIAA PAPER 91-3210) Copyright

A theorem relating wave drag to the integrated entropy rise along a shock wave is applied to deduce several useful scaling properties of the wave drag coefficient. These are shown to afford an accurate correlation of data and CFD predictions of the wave drag increase with local Mach number. Author

A91-54015*# Old Dominion Univ., Norfolk, VA.

SENSITIVITY ANALYSIS, APPROXIMATE ANALYSIS, AND DESIGN OPTIMIZATION FOR INTERNAL AND EXTERNAL VISCOUS FLOWS

ARTHUR C. TAYLOR, III, GENE W. HOU, and VAMSHI M. KORIVI (Old Dominion University, Norfolk, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 36 p. refs (Contract NAG1-1265)

(AIAA PAPER 91-3083) Copyright

A gradient-based design optimization strategy for practical aerodynamic design applications is presented, which uses the 2D thin-layer Navier-Stokes equations. The strategy is based on the classic idea of constructing different modules for performing the major tasks such as function evaluation, function approximation and sensitivity analysis, mesh regeneration, and grid sensitivity analysis, all driven and controlled by a general-purpose design optimization program. The accuracy of aerodynamic shape sensitivity derivatives is validated on two viscous test problems: internal flow through a double-throat nozzle and external flow over a NACA 4-digit airfoil. A significant improvement in aerodynamic performance has been achieved in both cases. Particular attention is given to a consistent treatment of the boundary conditions in the calculation of the aerodynamic sensitivity derivatives for the classic problems of external flow over an isolated lifting airfoil on 'C' or 'O' meshes. O.G.

A91-54027# Lockheed Engineering and Sciences Co., Hampton, VA.

A COMPARISON OF ARROW, TRAPEZOIDAL AND M WING CONCEPTS USING A MACH 2 SUPERSONIC CRUISE TRANSPORT MISSION

GLENN L. MARTIN, DAVID C. TICE (Lockheed Engineering and Sciences Co., Hampton, VA), DON C. MARCUM, JR. (NASA, Langley Research Center, Hampton, VA), and JONATHAN A. SEIDEL (NASA, Lewis Research Center, Cleveland, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 11 p. refs (AIAA PAPER 91-3102) Copyright

The present analytic study of the potential performance of SST configurations radically differing from arrow-winged designs in lifting surface planform geometry gives attention to trapezoidal-wing and M-wing configurations; the trapezoidal wing is used as the baseline in the performance comparisons. The design mission was all-supersonic (Mach 2), carrying 248 passengers over a 5500 nautical-mile range. Design constraints encompassed approach speed, TO&L field length, and engine-out second-segment climb and missed-approach performance. Techniques for improving these configurations are discussed. O.C.

A91-54059#

METHODS TO DETERMINE LIMITS TO TILTWING CONVERSION

MATTHEW J. O'ROURKE and JOHN W. RUTHERFORD (McDonnell Douglas Helicopter Co., Mesa, AZ) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 10 p. refs (AIAA PAPER 91-3143) Copyright

A model is developed that correlates well with flight tests of previous tilt-wing aircraft and provides the designer with a tool to define the relationships of disk loading and wing loading for a desired descent capability. The high-lift capability of the wing determines the ratio of wing loading to disk loading for the desired descent capability. It is concluded that application of extensive high-lift devices will enhance the effectiveness of the tilt-wing. R.E.P.

A91-54061*# McDonnell-Douglas Research Labs., Saint Louis, MO.

VSTOL GROUND EFFECTS TESTING WITH FLOW VISUALIZATION AND IMAGE ENHANCEMENT

JEROME T. KEGELMAN (McDonnell Douglas Research Laboratories, Saint Louis, MO) and ALBERT L. JOHNS (NASA, Lewis Research Center, Cleveland, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (Contract NAS3-25629) (AIAA PAPER 91-3145) Copyright

A remotely controlled high-energy fiber-optic light delivery technique is employed to examine the implementation of a laser-light-sheet flow-visualization system. During testing, video data are enhanced in real time using digital image processing techniques. A summary of test results for an advanced VSTOL configuration in ground effect, and techniques for the generation of 3D reconstructions for the flowfield are outlined. The system performed well during all phases of the test and proved to be an extremely useful asset to the overall test program. The most useful application of the flow visualization system was the interactive real-time flow field analysis made during the actual testing. P.D.

A91-54094*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

WING DESIGN CODE USING THREE-DIMENSIONAL EULER EQUATIONS AND OPTIMIZATION

I-CHUNG CHANG, FRANCISCO J. TORRES (NASA, Ames Research Center, Moffett Field, CA), and C. P. VAN DAM (California, University, Davis) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3190)

This paper describes a new wing design code which is based on the Euler equations and a constrained numerical optimization technique. The geometry modification is based on a set of fundamental modes define on the unit interval. A design example involving a high speed civil transport wing is presented to demonstrate the usefulness of the design code. It is shown that the use of an Euler solver in the direct numerical optimization procedures is affordable on the current generation of supercomputers. Author

A91-54250

A NUMERICAL METHOD FOR THE SELF-SIMILAR HYPERSONIC VISCOUS SHEAR LAYER

M. D. MATARRESE and A. F. MESSITER (Michigan, University, Ann Arbor) Journal of Computational Physics (ISSN 0021-9991), vol. 96, Oct. 1991, p. 475-483. Research supported by U.S. Army. refs

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A Newton-based finite-difference method employing continuation has been successfully applied to the problem which arises in an asymptotic description of 'hypersonic strong viscous interaction' in the presence of large surface mass injection. The appropriate continuation-path choice which accounts for the singular character of the solution is shown, and the behavior of neighboring solutions relevant to hypersonic flow is demonstrated. O.C.

A91-54260

CONVECTION VELOCITY IN A SUPERSONIC TURBULENT BOUNDARY LAYER

ERIC F. SPINA (Syracuse University, NY), JOHN F. DONOVAN (McDonnell Douglas Research Laboratories, Saint Louis, MO), and ALEXANDER J. SMITS (Princeton University, NJ) IN: Symposium on Turbulence, 12th, Rolla, MO, Sept. 24-26, 1990, Preprints. Rolla, MO, University of Missouri-Rolla, 1990, p. A21-1 to A21-11. refs Copyright

This paper describes the measurement of convection velocities in a Mach 3 boundary layer using streamwise-separated hot wires. The broad-band convection velocity, U , determined from space-time correlations, is 0.9 freestream U across the entire outer region of the boundary layer. The convection velocity was decomposed into frequency components using cross-spectral techniques. These average results reveal that large-scale motions convect more rapidly than small-scale motions in the lower part of the boundary layer, but not in the outer part. Convection velocities were also calculated for individual large-scale structures by means of a conditional sampling technique. The resulting distribution indicates that the majority of the large-scale structures convect at nearly the same velocity. The similarity of the present results with previous measurements taken over a wide range of Reynolds numbers and Mach numbers suggests the existence of a 'universal' convection velocity profile. Author

A91-54284

VISUAL STUDY ON VORTEX DEVELOPMENTS OVER AIRFOILS AFTER IMPULSIVE START

F. FINAISH (Missouri-Rolla, University, Rolla) IN: Symposium on Turbulence, 12th, Rolla, MO, Sept. 24-26, 1990, Preprints. Rolla, MO, University of Missouri-Rolla, 1990, p. B31-1 to B31-9. refs (Contract F49620-84-C-0065)

Copyright

Vortex structures and processes over airfoils at high angles of attack are visualized by means of a system that permits the generation of impulsive air flow. A movie camera photographs the smoke generated by liquid titanium tetrachloride on an airfoil surface on a stationary support with a pickup mechanism. Photographic sequences generated by the system permit the study of flow separation and resulting vortex formation, as well as the initiation of steady-state vortex shedding. C.C.S.

A91-54286

NEW DEVELOPMENTS IN UNDERSTANDING SUPERSONIC TURBULENT BOUNDARY LAYERS

A. J. SMITS (Princeton University, NJ) IN: Symposium on Turbulence, 12th, Rolla, MO, Sept. 24-26, 1990, Preprints. Rolla, MO, University of Missouri-Rolla, 1990, p. IL4-1 to IL4-19. refs (Contract AF-AFOSR-90-0217; AF-AFOSR-89-0420) Copyright

Recent research regarding the structure of turbulent boundary layers is reviewed with particular attention given to the incorporation of the effects of the Mach and Reynolds numbers in supersonic flows. Related physical phenomena are listed, and a simple model is given relating the Mach and Reynolds numbers by accounting for the decrease in the rate of decay of large-scale motions. An evolutionary model is proposed for describing the growth of the boundary layer at nonhypersonic Mach numbers which accounts for both Reynolds-number effects and asimilar vortex loops.

C.C.S.

A91-54354

THEORY AND SHOCK TUNNEL EXPERIMENTS ON FLOW PAST SUPERSONIC VEHICLES

M. YASUHARA, Y. NAKAMURA, K. TSUBOI, and K. KUWABARA (Nagoya University, Japan) Nagoya University, Faculty of Engineering, Memoirs (ISSN 0027-7657), vol. 42, no. 2, 1990, p. 290-359. refs

First, analytical theory of high supersonic flow past basic slender bodies is described, for both parallel and source type flows. In the analysis, the flowfield is divided into the inviscid shock layer and the viscous boundary layer. Second, simulations of flow by various methods of CFD are described for basic bodies as well as complicated ones like winged bodies. Next, experiments performed by using the Mach 8 shock tunnel at Nagoya University are described, especially for measuring pressure distributions, shock wave contours and force coefficients. It is shown that, as a whole, theoretical results give good comparisons with experimental ones. It is also shown that, in some cases, the simulations by the CFD can proceed beyond analytical methods where analyses cannot prescribe the flow natures. Nevertheless, it is shown that, presently, the CFD simulations are not yet complete, and some of analytical approaches can give more informations about the flow nature, and further, experimental verifications are always important.

Author

A91-54366* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

NUMERICAL SIMULATION OF HIGH-INCIDENCE FLOW OVER THE F-18 FUSELAGE FOREBODY

LEWIS B. SCHIFF, RUSSELL M. CUMMINGS, REESE L. SORENSON, and YEHIA M. RIZK (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 609-617. Previously cited in issue 09, p. 1279, Accession no. A89-25286. refs Copyright

A91-54370

NAVIER-STOKES SIMULATION OF BURST VORTEX FLOWFIELDS FOR FIGHTER AIRCRAFT AT HIGH INCIDENCE

JOSEPH VADYAK and DAVID M. SCHUSTER (Lockheed Aeronautical Systems Co., Marietta, GA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 638-645. Research supported by Lockheed Independent Research and Development Program. Previously cited in issue 21, p. 3251, Accession no. A89-47651. refs Copyright

A91-54371

LOW-SPEED AERODYNAMIC CHARACTERISTICS OF CLOSE-COUPLED CANARD CONFIGURATION AT INCIDENCE AND SIDESLIP

G. BANDYOPADHYAY (Indian Institute of Technology, Kharagpur, India) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 646-651. Research supported by Aeronautics Research and Development Board of India. refs Copyright

A numerical method has been developed for the prediction of

low-speed aerodynamic characteristics of close-coupled canard configurations at zero and nonzero sideslipping angles, taking into consideration the effect of separation along the leading edges of the canard. The method is based on the nonplanar vortex lattice model in which free vortex sheets separating from the leading edges of the canard and trailing edges of both canard and main wing are represented by multiple nonintersecting line vortices. To illustrate the effect of canard leading-edge flow separation, attached flow solutions, based on the vortex-lattice model, are also obtained for zero and nonzero sideslipping angles. To check the accuracy of the separated flow solution, experimental tests have been conducted in a low-speed wind tunnel on a canard model at 0- and 10-deg sideslipping angles. The comparison shows good agreement for both cases up to approximately 16-deg incidence.

Author

A91-54373

APPLICATION OF XTRAN3S AND CAP-TSD TO FIGHTER AIRCRAFT

D. M. PITT, D. F. FUGLSANG, and D. V. DROUIN (McDonnell Aircraft Co., Saint Louis, MO) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 657-663. Previously cited in issue 11, p. 1604, Accession no. A90-29360. refs (Contract F33615-87-C-3212) Copyright

A91-54446

PARABOLIZED NAVIER-STOKES CALCULATIONS OF SUPER- AND HYPERSONIC 3D FLOW FIELDS

Y. YILMAZ, R. GRUNDMANN (Institut von Karman de Dynamique des Fluides, Rhode-St.-Genese, Belgium), and S. RIEDELBAUCH (DLR, Goettingen, Federal Republic of Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 15, Aug. 1991, p. 227-236. refs Copyright

A computer program to solve the 3D supersonic/hypersonic external flow fields has been developed. The flow is supposed to be nonreacting. A simplified form of the Navier-Stokes equations, namely the Parabolized Navier-Stokes equations, are solved by using a conservative, implicit, noniterative factored finite difference algorithm. Cross-sectional global mass conservation is used to evaluate the streamwise pressure gradient to remove the elliptic behavior through the subsonic boundary layer. Computed results are presented for conical supersonic flow fields and hypersonic ramp flow.

Author

A91-54711

AERODYNAMICS OF MULTIPLE WING SYSTEMS FOR LOW REYNOLDS NUMBER RPVS

ALVIN CROSS and BRIAN J. DONNELLY (U.S. Navy, Naval Research Laboratory, Washington, DC) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 14.1-14.15. Research supported by U.S. Navy. refs Copyright

Experimental results and conclusions are presented based upon 3D wind tunnel testing of a model that is configurable with multiple wings at various locations, i.e., variable stagger, variable gap. This testing provides the data required to establish the viability of multiple wing configurations for high performance flight at low Reynolds number conditions. A data base consisting of system lift to drag ratio, longitudinal static stability, stall behavior, endurance parameter, and packaging was established from the complete matrix of configurations.

R.E.P.

A91-54713

A STUDY OF THE POTENTIAL FOR VISCOUS DRAG REDUCTION ON SMALL RPVS

K. KNOWLES (Royal Military College of Science, Shrivenham, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 16.1-16.6. refs Copyright

A study to assess the potential benefits of utilizing passive drag reduction devices on small RPVs is presented. Aircraft drag components have first been estimated; pressure and viscous drags, wing induced, and fuselage viscous and pressure drags. Wing induced drag depends on geometry; viscous drag depends on the transition Reynolds number, which then depends on pressure gradient, surface finish and the level of external disturbances. It is shown that the level of benefit from turbulent drag reduction depends on these factors, of which some are dependent on vehicle size. R.E.P.

A91-54849

A COMPRESSIBLE THREE-DIMENSIONAL DESIGN METHOD FOR RADIAL AND MIXED FLOW TURBOMACHINERY BLADES

M. ZANGENEH (University College, London, England) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 13, Sept. 5, 1991, p. 599-624. Research supported by Holset Turbochargers, Ltd. and St. John's College. refs Copyright

A fully 3D compressible inverse design method for the design of radial and mixed flow turbomachines is described. In this method the distribution of the circumferentially averaged swirl velocity on the meridional geometry of the impeller is prescribed, and the corresponding blade shape is computed iteratively. Two approaches are presented for solving the compressible flow problem. In the approximate approach, the pitchwise variation in density is neglected, and as a result the algorithm is simple and efficient. In the exact approach, the velocities and density are computed throughout the 3D flowfield by employing a fast Fourier transform in the tangential direction. The results of the approximate and exact approach are compared for the case of a high-speed (subsonic) radial-inflow turbine, and it is shown that the difference between the blade shapes computed by the two methods is well within the manufacturing tolerances. Author

A91-54860* Old Dominion Univ., Norfolk, VA.

NAVIER-STOKES CALCULATIONS OF TRANSONIC FLOWS PAST CAVITIES

O. BAYSAL (Old Dominion University, Norfolk, VA) and S. SRINIVASAN ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Sept. 1991, p. 368-376. refs (Contract NCC1-121) Copyright

Presented in this paper is a computational investigation of subsonic and transonic flows past three-dimensional deep and transitional cavities. Simulations of these self-induced oscillatory flows have been generated through time-accurate solutions of the Reynolds averaged, full Navier-Stokes equations, using the explicit MacCormack scheme. The Reynolds stresses have been included through the Baldwin-Lomax algebraic turbulence model with certain modifications. The computational results include instantaneous and time averaged flow properties. The results of an experimental investigation have been used not only to validate the time-averaged results, but also to investigate the effects of varying the Mach number and the incoming boundary-layer thickness. Time series analyses have been performed for the instantaneous pressure values on the cavity floor and compared with the results obtained by a predictive formula. While most of the comparisons have been favorable, some discrepancies have been observed, particularly on the rear face. The present results help understanding the three-dimensional and unsteady features of the separations, vortices, the shear layer, as well as some of the aeroacoustic phenomena of compressible cavity flows. Author

A91-54867

EXPERIMENTAL AND ANALYTICAL STUDY OF FLOW DIVERSION BEYOND AN UNDEREXPANDED NOZZLE

E. C. HANSEN (Florida, University, Gainesville) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Sept. 1991, p. 475-478. Research supported by USAF. refs Copyright

A steady-state flow apparatus was used to investigate the process of gun gas diversion through a single hole perforated

disk diverter. The amount of diverted flow was found to depend on the distance between the nozzle and the diverter disk and the ratio of nozzle pressure to diverter exit pressure. Experimental studies used nitrogen and carbon dioxide as the working fluids to show the effect of specific heat ratio. At ratios of nozzle pressure to ambient pressure ranging from 4 to 60 diversion efficiencies of 50 to 99 percent were produced. A one-dimensional analytic gas flow model was developed. Results of the analytic model paralleled the experimental data for pressure ratios over 10. Author

A91-54870

VISUALIZATION OF THE WING-TIP VORTEX IN TEMPORAL AND SPATIAL PRESSURE GRADIENTS

X. LIANG (Tsinghua University, Beijing, People's Republic of China) and B. R. RAMAPRIAN (Washington State University, Pullman) ASME, Transactions, Journal of Fluids Engineering (ISSN 0098-2202), vol. 113, Sept. 1991, p. 511-515. refs (Contract DAAL03-87-G-0011) Copyright

The evolution of the longitudinal vortex in the near field of a rectangular wing has been visualized using smoke and laser light sheet. The smoke photographs have been used to obtain qualitative and some quantitative information on the effect of small temporal and spatial pressure gradients on the evolution of the vortex in this region. The experiments indicate that even small temporal retardation of the flow can produce a significant increase in the vortex size. This effect becomes larger with increase in retardation, angle of incidence and distance downstream from the trailing edge. Also, vortex 'breakdown' was found to occur in many temporal-deceleration experiments. The vortex evolution was, however, found to be relatively insensitive to the presence of small spatial adverse pressure gradients along the flow direction. The study is preliminary in nature and needs to be supported by more extensive quantitative measurements. Author

A91-54954

MEASUREMENTS AND STABILITY CALCULATIONS OF THE DISTURBANCE GROWTH IN AN UNSTABLE THREE-DIMENSIONAL BOUNDARY LAYER

H. BIPPES, B. MUELLER (DLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany), and M. WAGNER (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) Physics of Fluids A (ISSN 0899-8213), vol. 3, Oct. 1991, p. 2371-2377. refs Copyright

The amplification of disturbances developing under conditions of natural transition in the unstable three-dimensional boundary-layer flow on a swept-back flat plate is measured with the aid of hot-wire anemometry. A detailed analysis of the experimental data allows identification of the most amplified instability modes and determination of their growth rates. The results are compared with linear stability theory. Although the amplification process is affected by nonlinearities starting a short distance downstream of the positions where the disturbances become of measurable size, in some essential respects the applicability of linear theory can be examined. It turns out that the initial amplification rates of the stationary instability modes are fairly well predicted whereas the amplification rates of the nonstationary modes are overestimated. A remarkable feature is that the disturbances with the largest amplitudes are not, in every case, the most amplified ones in theory as well as in experiment. Author

A91-55029

SOME METHODS FOR IMPROVING THE CONVERGENCE OF ITERATIVE SOLUTIONS OF TRANSONIC FLOW EQUATIONS

R. TREBINSKI (Military Technical Academy, Warsaw, Poland) Archiwum Mechaniki Stosowanej (ISSN 0373-2029), vol. 42, no. 2, 1990, p. 183-195. refs Copyright

Some new methods for accelerating the convergence of iteration procedures for solving equations of transonic flow are

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examined. In particular, attention is given to an algorithm for solving steady flow equations based on explicit difference schemes approximating equations of unsteady flow. Modified versions of the standard algorithm are proposed. The efficiency of the convergence-accelerating methods proposed here is demonstrated using a test problem. V.L.

A91-55033

WAKE OF TWO FLAT PLATES IN PARALLEL AND ACOUSTIC RESONANCE

V. RAMJEE and P. ASOKAN (Indian Institute of Technology, Madras, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, Feb. 1991, p. 13-17. refs

The effect of acoustic resonance in a rigid walled duct on the development of a wake of two flat plates was investigated by studying the mean velocity profiles in the wake of two flat plates with a rounded leading edge and a square trailing, which were kept in a parallel position with a gap between them that is varied from 20 mm to 40 mm. Experimental measurements were conducted in a blower wind tunnel, and the measurements were taken with and without acoustic resonance. Results showed that, in the wake, the velocity defect at the center was greater in the resonant condition than in the absence of resonance. When the gap was 20 mm, the wake of two parallel plates appeared similar to that of single flat plate, while at large gap (40 mm), a double-hump velocity profile appeared in the wake, which vanished faster under the resonant than under nonresonant condition. The turbulent intensities were higher in the resonant condition than they were without resonance. I.S.

A91-55148

THE STRUCTURE OF THREE-DIMENSIONAL FREE-INTERACTIONS IN EXTERNAL, STEADY, COMPRESSIBLE FLOWS

J. W. ELLIOTT (Hull, University, England), A. P. ROTHMAYER (Iowa State University of Science and Technology, Ames), and F. T. SMITH (University College, London, England) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 10, no. 3, 1991, p. 227-251. Research supported by NSF and United Technologies Corp. refs

Copyright

Three-dimensional, steady, viscous-inviscid interactions are investigated initially for compressible flows on triple-deck scales and then on shorter and longer spanwise length scales. Three-dimensional stall cells, similar in form to those seen experimentally, are shown to be possible over a wide range of spanwise wavelengths for both subsonic and supersonic flow. For weakly 3D supersonic flow, the 2D free-interaction is recovered but in a form which can still admit a fully 3D separation. R.E.P.

A91-55253

SUPERSONIC LAMINAR FLOW PAST THE WINDWARD SIDE OF INFINITE-SPAN SWEEPED WINGS OVER A WIDE RANGE OF REYNOLDS NUMBERS [SVERKHZVUKOV OE LAMINARNOE OBTEKANIE NAVETRENNOI CHASTI SKOL'ZIASHCHIKH KRYL'EV BESKONECHNOGO RAZMAKHA V SHIROKOM DIAPAZONE CHISEL REINOL'DSA]

I. V. VERSHININ, G. A. TIRSKII, and S. V. UTIUZHNIKOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1991, p. 40-44. In Russian. refs

Copyright

The problem of supersonic flow past swept wings over a wide range of Reynolds numbers (from small Re corresponding to the onset of continuous flow to large Re corresponding to the theory of an asymptotically thin boundary layer) is analyzed using a model based on full equations of a viscous shock layer. The numerical calculations are performed using independent variables and a difference scheme. Results of calculations are presented and compared with experimental data in the literature. V.L.

A91-55257

EXCITATION OF UNSTABLE MODES IN A SUPERSONIC BOUNDARY LAYER BY ACOUSTIC WAVES [VOZBUZHDENIE NEUSTOICHIVYKH MOD V SVERKHZVUKOVOM POGRANICHNOM SLOE AKUSTICHESKIMI VOLNAMI]

A. V. FEDOROV and A. P. KHOKHLOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1991, p. 67-74. In Russian. refs

Copyright

An analytical study is made of first and second mode generation in the boundary layer by acoustic waves in the vicinity of the sharp leading edge of a plate in supersonic flow of a gas. The problem is solved asymptotically, and the results are found to be in good agreement with an exact solution. Under certain conditions, the first and second mode are found to synchronize with acoustic waves propagating parallel to the plate surface. Calculations based on a full system of linearized Navier-Stokes equations indicate that the synchronization effect is maintained when viscosity is taken into account. V.L.

A91-55264

SLIGHTLY CURVED THIN WINGS WITH A MAXIMUM LIFT-DRAG RATIO [TONKIE SLABOIZOGNUTYE KRYL'IA S MAKSIMAL'NYM AERODINAMICHESKIM KACHESTVOM]

IU. G. BOKOVNIKOV and E. M. PROKHOROV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1991, p. 165-168. In Russian. refs

Copyright

Flow past lifting wings characterized by a low perturbation level in supersonic flow is analyzed using the Prandtl scheme. A numerical model is constructed in a class of piecewise constant functions on characteristic computational grids. The variational problem of determining the slightly curved middle surface of the wing corresponding to a maximum lift-drag ratio is reduced to a nonlinear programming problem, which is solved by the gradient projection method. V.L.

A91-55268

A CONE IN SUPERSONIC FLOW NEAR A SURFACE WITH A TURBULENT BOUNDARY LAYER [KONUS V SVERKHZVUKOVOM POTOKE VBLIZI POVERKHNOSTI S TURBULENTNYM POGRANICHNYM SLOEM]

A. I. ZUBKOV, B. E. LIAGUSHIN, and IU. A. PANOV Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1991, p. 177-180. In Russian. refs

Copyright

Results of an experimental study of supersonic flow (Mach 3, stagnation pressure 1.2 MPa) past cones located near a surface with a thick turbulent layer are reported. Depending on the intensity of the incident shock wave, four characteristic shock wave configurations are formed on the reflection of the shock. Some quantitative data are presented which characterize changes in the size of the separated flow region and characteristic pressures in this region. V.L.

A91-55453

AERODYNAMIC RESPONSE OF A THIN AIRFOIL FLYING OVER AND IN PROXIMITY TO A WAVY WALL SURFACE - LIFTING SURFACE THEORY

MASAMI ICHIKAWA and SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, Aug. 1991, p. 395-402. In Japanese. refs

The paper investigates the aerodynamic response of a thin airfoil flying over and in proximity to a wavy wall surface which moves in the same direction as free stream but with a different velocity. The integral equation method (relating the pressure on boundaries to downwash velocity) is adopted for formulation, based on inviscid and small-perturbation flow. The wall is considered to be sinusoidal and the airfoil is considered to be a flat plate at zero incidence, and numerical calculations are made with a set of important parameters including airfoil height from the wall, wave length of wall surface, and the wall velocity. The influence of such parameters on the aerodynamic coefficients is divided into

two parts: 'first-order ground effect' and 'second-order ground effect'. The latter is discussed in detail through the solution of a Kemp-type gust. Numerical results show that the wave length and the traveling velocity of the wall within a certain range have a great influence on the 'second-order ground effect', with proximity to the ground. Author

A91-55561

EXTREME FORCES IN THE PROPELLER [EXTREMNI SILY VRTULE]

JAROSLAV SALGA and JIRI SVEDA Zpravodaj VZLU (ISSN 0044-5355), no. 4, 1991, p. 191-196. In Czech. refs Copyright

The aerodynamic forces acting on a propeller are analyzed. In particular, attention is given to the conditions under which these forces may exceed the propeller thrust in normal flight regimes. Calculations are presented for a V 518 x 16 propeller. V.L.

A91-55642

DRAG REDUCTION BY PASSIVE DEVICES - A REVIEW OF SOME RECENT DEVELOPMENTS

A. M. SAVILL (Cambridge, University, England) IN: Structure of turbulence and drag reduction; Proceedings of the IUTAM Symposium, Zurich, Switzerland, July 25-28, 1989. Berlin and New York, Springer-Verlag, 1990, p. 429-465. Research supported by Rolls-Royce, PLC, Airbus Industrie, British Council, et al. refs (Contract SERC-GR/E/0682/4) Copyright

Recent developments in drag reduction by passive means are reviewed with emphasis on the latest results obtained for both riblets and airfoil manipulators, particularly at high Reynolds numbers. Attention is also given to other approaches and combinations of techniques, studies of alternative surface geometries, modeling, and some previously unpublished findings. V.L.

A91-55644* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

BOUNDARY LAYER MANIPULATORS AT HIGH REYNOLDS NUMBERS

J. B. ANDERS (NASA, Langley Research Center, Hampton, VA) IN: Structure of turbulence and drag reduction; Proceedings of the IUTAM Symposium, Zurich, Switzerland, July 25-28, 1989. Berlin and New York, Springer-Verlag, 1990, p. 475-482. refs Copyright

Airfoil large-eddy breakup (LEBU) devices were tested on an axisymmetric body in the Langley Two Tank up to speeds of 50 ft/sec. NACA-0009, NACA-2412, E-193, and Clark Y contours were tested in single and tandem configurations. At the higher Reynolds numbers local skin friction downstream of the devices showed minimal reductions O (10 percent) and total body drag was increased 1 to 3 percent. At lower Reynolds numbers skin-friction reductions as large as 25 percent were measured and total body drag tended toward net reductions. The loss of effectiveness with increasing Reynolds number of conventional, outer layer devices suggests a decoupling of the outer and inner scales in high Reynolds number turbulent boundary layers. Author

A91-55716

FLOW ANALYSIS AROUND ROTARY WING

S. SAITO (National Aerospace Laboratory, Chofu, Japan), Y. MATSUO, Y. OKUNO, and T. AOYAMA (Tokyo, University, Japan) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 305-310. refs Copyright

Flow patterns on a rotary wing are investigated by using numerical calculations solving Navier-Stokes equations. By computer graphics techniques, the flow around a rotary wing was visualized and compared with experiments. They showed that the numerical results were in good agreement with the experiments

and the computer graphics techniques combined with numerical analysis can potentially visualize flow patterns, specifically for vortical flows. Author

A91-55722

VISUALIZATION OF A TRANSLATING AND OSCILLATING AIRFOIL WITH DIFFERENT CROSS SECTIONS

K. OHMI (Osaka University, Japan), M. COUTANCEAU (Poitiers, Universite, France), T. P. LOC, and A. DULIEU (CNRS, Laboratoire d'Informatique pour la Mecanique et les Sciences pour l'Ingenieur, Orsay, France) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 352-359. Research supported by DRET. refs Copyright

Some experimental and numerical visualizations have been made on the starting flows past a two-dimensional airfoil oscillating in pitch at large incidences. The model airfoil, ellipse or NACA 0012 in cross section, is set in motion impulsively and subjected simultaneously to a steady translation and a harmonic oscillation around the pitching axis situated at mid-chord. The Reynolds number based on the chord length is fixed at 3000 and the reduced frequency ranges between 0.1 and 1.0. The mean incidence and the angular amplitude have provided two varied values. Author

A91-55725

FLows AROUND RECTANGULAR PRISMS WITH THE OSCILLATING FLAPS AT LEADING EDGES

TAKETO MIZOTA (Fukuoka Institute of Technology, Japan) and ATSUSHI OKAJIMA (Kanazawa University, Japan) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 377-382. Research supported by MOESC and Fukuoka Institute of Technology. refs Copyright

The wake velocity and the surface pressure of a rectangular prism are measured with the oscillation of leading edge flaps, and the locking-in phenomenon between flow and flap oscillation is discussed. Smoke-wire techniques are also conducted for flow visualization around this model. As a result, it is concluded that the effects of flap oscillation on near-wakes and surface pressures are very similar to ones of a heaving oscillation of a model. Author

A91-55730

VORTEX PATTERNS BEHIND AIRFOILS IN STREAMWISE ORIENTATION

P. FREYMUTH, R. TRASEWICZ, and W. BANK (Colorado, University, Boulder) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 443-448. Previously announced in STAR as N91-20049. refs (Contract F49620-84-C-0065) Copyright

Streamwise oscillation or lunging airfoils have been previously investigated for their lift characteristics with only minor attention given to flow visualization. Therefore, a limited parametric exploration of the two-dimensional vortex patterns of lunging airfoils, which supplement similar investigations in other separating flow configurations, is emphasized. Author

A91-55733

AIR FLOW VISUALIZATION APPLIED TO THE STUDY OF VORTEX BREAKDOWN

J. L. SOLIGNAC (ONERA, Chatillon, France) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 490-496. refs Copyright

A study is presented of vortex breakdown unsteadiness based on local measurements utilizing LDV and hot wire anemometry and of spatial instantaneous measurements from short exposure time photographs or from high speed motion pictures. The flaps

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aperture and the wing angle of attack are two main parameters controlling respectively the adverse pressure gradient and the intensity of the vortex. Thus the vortex breakdown can be located at a position behind the wing. R.E.P.

A91-55735

A SMOKE WIRES FLOW VISUALIZATION STUDY OF THE WAKES OF BLUFF BODIES WITH DIFFERENT AFTERBODIES

S. C. LUO and Y. T. CHEW (National University of Singapore, Singapore) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 503-508. refs

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In the present investigation the vortex street wakes of six different bluff bodies are visualized by a twin smoke wires technique. It is observed that while the main features of these wakes are similar, the details vary. The vortex formation length of the six bluff bodies are estimated from flow visualization results, and the relative magnitude of the drag coefficients and the Strouhal numbers which are both related to the vortex formation length are deduced. The deductions made are found to agree with experimental measurements. Author

A91-55736

SHOCK SHAPES OVER SLIGHTLY BLUNTED WEDGES TRAVELING AT HYPERSONIC SPEED

M. NISHIO and T. KIMURA (Kobe University, Japan) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 511-516. refs

Copyright

Shock shapes over slightly blunted wedges traveling at a hypersonic speed were investigated under the condition of various wedge angles. The shock shapes were visualized by using an electrical discharge. The results showed that when the wedge angles were large enough, the shock shapes agreed with the theoretical shock shapes. However, when the wedge angles became smaller, the visualized shock angles became larger than the theoretical ones. Author

A91-55745

IDENTIFICATION OF MULTIPLE VORTICES ON COMPLEX DELTA WING CONFIGURATIONS

R. C. NELSON and P. E. OLSEN (Notre Dame, University, IN) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 597-602. refs

Copyright

A method for marking and identifying multiple vortices on complex slender wings is presented. By introducing titanium tetrachloride at the apex and strake wing juncture, multiple leading edge vortices can be easily identified. The titanium tetrachloride vapor reacts with the moisture in the air to create a dense white smoke that is entrained in the vortex cores. Both plan and side views of the marked vortex cores were recorded photographically. The flow visualization photographs were used to determine the trajectories of the vortices as a function of angle of attack. Author

A91-55747

VORTEX DETACHING IN SEVERAL SPOILERS - EXPERIMENTAL DATA

P. A. GILI and P. SAVORELLI (Torino, Politecnico, Turin, Italy) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 623-630. refs

Copyright

Spoilers and flaps were tested on a wing in the Turin Polytechnic Aeronautical and Space Department's D 3M subsonic wind tunnel. Six spoiler shapes were investigated. In the wind tunnel, downstream of the wing a single hot wire was assembled on a stand with three degrees of freedom and then connected to a

spectrum analyzer. The frequencies of vortex detaching from spoilers were investigated in each configuration, with and without flaps. Some shapes produce two separate main kinds of vortices, frequencies in the one being twice that in the other and each one covering a distinct detaching area, one above the other. Visualization by smoke techniques confirmed these results as photography shows. Author

A91-56112

MEASUREMENTS OF THE EFFECTS OF WINGLETS ON TIP-LEAKAGE LOSSES IN A LINEAR TURBINE CASCADE

M. I. YARAS and S. A. SJOLANDER (Carleton University, Ottawa, Canada) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 127-135. Research supported by Pratt and Whitney Canada. refs

(Contract NSERC-A-1671)

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Measurements are presented for the effect of winglets, or minishrouds, on the tip-leakage flow in a cascade of turbine blades. Three different winglet geometries are examined. Data are presented for clearances of 2.4 and 3.7 percent of the blade chord and the influence of relative wall motion is examined for the smaller clearance. Some beneficial effects are observed: all three winglets reduced the tip-leakage losses by the order of 10 percent, with the double-sided winglet being marginally best; and the distortion of the blade loading near the tip is reduced by the use of winglets. The physical mechanisms behind the changes are discussed. Author

A91-56114

AN INVESTIGATION OF THE FLOW WITHIN THE CLEARANCE SPACE OF A COMPRESSOR BLADE TIP

J. A. STORER and J. P. BARTON (Rolls-Royce, PLC, London, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 143-151. Research supported by Rolls-Royce, PLC. refs

Copyright

An investigation is made of the structure of the flow in the tip gap of a compressor cascade, and the ability to calculate it using three-dimensional Navier-Stokes methods. Two cases are examined in detail: one in which the clearance flow separates from the pressure-side corner on entering the tip gap and subsequently reattaches, and one in which the clearance flow separates and remains separated. The length to reattachment is shown to be insensitive to the local Reynolds number, suggesting that the reattachment is inviscidly controlled. Consequently, the flow can be predicted by a Navier-Stokes calculation using a fairly basic turbulence model and, in cases in which it remains separated, be captured by a relatively coarse calculation mesh. A simple criterion for predicting reattachment length based on the ratio of the tip gap height to the blade thickness is proposed, so that the mesh near the blade tip can be tailored accordingly. Author

A91-56115* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

A NAVIER-STOKES STUDY OF SHOCK-BOUNDARY LAYER INTERACTION AND FLOW SEPARATION INSIDE A TRANSONIC COMPRESSOR

CHUNILL HAH (NASA, Lewis Research Center, Cleveland, OH) and STEVEN L. PUTERBAUGH (USAF, Aero Propulsion Laboratory, Wright-Patterson AFB, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 152-162. refs

Copyright

A numerical study to evaluate a three-dimensional Navier-Stokes method as a tool to predict the detailed flowfield inside a low-aspect-ratio compressor at off-design rotor speed has been conducted. The flow field inside a state-of-the-art transonic

compressor is used for the purpose of the evaluation. The experimental study shows that the rotor has higher peak efficiency at 90 percent rotor speed than at 100 percent rotor speed. The details of the flow structure inside the low-aspect-ratio compressor (three-dimensional shock structure, shock-boundary layer interaction, tip leakage vortex, etc.) and the overall aerodynamic performance at various operating conditions are numerically analyzed, and the results are compared with the available experimental data. The numerical results also indicate that the rotor has higher peak efficiency at 90 percent rotor speed than at 100 percent rotor speed. This is due to the reduced shock strength and the reduced interactions among passage shock, tip-clearance vortex and blade boundary layer. Author

A91-56130

QUASI-3D NUMERICAL MODEL OF A FLOW PASSAGE OF THE AVIATION GAS TURBINE ENGINES

M. IA. IVANOV and R. Z. NIGMATULLIN (Tsentrul'nyi Nauchno-Issledovatel'skii Institut Aviatsonnogo Motorostroeniia, Moscow, USSR) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 299-305. refs
Copyright

The paper discusses the quasi-three-dimensional numerical model of a flow passage of aviation gas turbine engines. This model accounts for the full three-dimensional geometry of different engine components, in particular, all blade rows. It is based on the three-dimensional Euler unsteady equation system. Introduced into the equation right parts, the source terms express the effects of viscous losses, leakages from the passage and tip clearances, and a selection or a blowing out of cooling air. Typical results for a multistage turbomachine, a fan with stator and rotor additional rows, and the whole core of a bypass air breathing engine are presented. Author

A91-56144

A NUMERICAL STUDY ON THREE DIMENSIONAL VISCOUS FLOWS OF A RADIAL-INFLOW TURBINE

T. YAMANE and T. NAGASHIMA (Tokyo, University, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 439-446. refs
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Numerical calculations have been performed for the analysis of three-dimensional viscous internal flow structure of a model radial-inflow turbine reported in NASA TP1730 which was originally designed for high inlet total temperature and has very thick blades for internal cooling. The numerical method employed for the present study is based upon the LU-ADI approximate factorization scheme applied for thin layer approximated compressible Navier-Stokes equations which incorporate the Baldwin-Lomax turbulence model. Computational results revealed a complex internal flow structure of secondary flows which is characteristic of the radial-inflow turbines and a strong radial flow from the hub to shroud along the trailing edge in the case of very thick blades. Comparisons with the experimental data of NASA TP1730 showed a good agreement with respect to mass flow rate and inlet-to-outlet total pressure ratio, but the computational results gave larger absolute flow angles at the rotor exit indicating less flow turning. Author

A91-56145

FLOW BEHAVIOUR IN CENTRIFUGAL IMPELLERS

S. RAMAMURTHY, K. MURUGESAN (National Aeronautical Laboratory, Bangalore, India), and D. PRITHVIRAJ (Indian Institute of Technology, Madras, India) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 447-453. refs
Copyright

Detailed investigations through hot-wire anemometry at the outlet of a centrifugal compressor impeller reveal a complex nature

of flow behavior both spatially across the blade to blade pitch and with respect to time. The relative flow angle and velocity do not fit into the conventional steady state jet-wake model nor the one-dimensional slip theory. A hypothesis that periodic vortices shed from the suction surface well inside the impeller sweeping across the impeller passage is put forward to explain the large variations in flow angle observed. Author

A91-56146

COMPARISON OF THE EXPERIMENTALLY DEFINED AND COMPUTED FLOW FIELD IN THE ROLLS ROYCE GEM IMPELLER

K. BIRDI (Rolls-Royce, PLC, London, England), C. P. FORSTER, and A. TOURLIDAKIS (Cranfield Institute of Technology, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 454-466. Research supported by Rolls-Royce, PLC. refs
Copyright

The flow field inside the Rolls-Royce Gem 2 centrifugal impeller has been measured using laser transit anemometry and analyzed using an elliptic, three-dimensional Navier-Stokes solution methodology. The experimental setup, the measurements procedure, and the results which are obtained for two operating conditions, one at peak efficiency and one near surge at 80 percent speed, are presented. The computational model is based on a finite volume, pressure correction algorithm and a modified two-equation k-epsilon model; the results obtained are compared favorably against the measured ones. Both the measurements and the computations demonstrate the appearance of a strong wake pattern in the middle of the blade passage attached to the shroud wall. Author

A91-56148

A STUDY OF ROTATING STALL IN A RADIAL COMPRESSOR STAGE

J. W. RAILLY (Birmingham, University, England), P. B. SHARMA (Delhi College of Engineering, India), and S. K. BANSAL (Indian Airlines, New Delhi, India) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 475-482. Research supported by National Engineering Laboratory of England. refs
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Rotating stall behavior of a radial compressor stage is examined using a linearized treatment of the stability of a compressor system. A relationship between the slope of compressor characteristic at the point of instability and the B parameter is obtained. The continuance of stall-free operation beyond the peak pressure point in the region of strong positive slope is confirmed by the experiments. The results indicate that rotating stall is completely suppressed by altering the inlet or exit configurations. Author

A91-56149

SIMULATION OF INVISCID BLADE ROW INTERACTION USING A LINEAR AND A NON-LINEAR METHOD

A. SUDDHOO, P. STOW (Rolls-Royce, PLC, Derby, England), and M. B. GILES (MIT, Cambridge, MA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 485-493. refs
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A linearized potential code and a nonlinear time-marching Euler code for the simulation of inviscid stator/rotor interactions are compared. The codes are applied to three different single-stage turbines which are typical of practical designs. Both subsonic and transonic flows are considered. The results show that good agreement between the two models can be obtained over a wide range of practical applications. The results also show the importance of relative blade numbers in the design of a stage. Author

A91-56151

NUMERICAL COMPUTATION AND MATHEMATICAL MODELLING OF FLOW THROUGH TRANSONIC COMPRESSOR CASCADES

K. CELIKOVSKY, K. FABICH (Aeronautical Research and Test Institute, Prague, Czechoslovakia), and P. M. BYVAL'TSEV (Tsentrallyy Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 504-513. refs
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The paper deals with the results of computation of flow patterns in transonic axial-flow compressor cascades and mathematical modeling the flowfield distribution in the cascade channel. Numerical method has been developed for this purpose. The method is based on the GODUNOV non-stationary differential analog of first order, later supplemented with a second order extension in the solution of the Riemann problem. Numerical calculations have been compared with a set of experimental results of transonic axial-flow compressor cascades measurements, carried out in a supersonic wind tunnel. Some calculations of the flow through the cascades have been carried out. Author

A91-56152* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THREE-DIMENSIONAL FLOWS IN A TRANSONIC COMPRESSOR ROTOR

LONNIE REID (NASA, Lewis Research Center, Cleveland, OH), MARK L. CELESTINA (Sverdrup Technology, Inc., Cleveland, OH), KENNETH DEWITT, and THEO KEITH (Toledo, University, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 514-527. refs
Copyright

This study involves an experimental and numerical investigation of the three-dimensional flows in a transonic compressor rotor. A variety of data which could be used, in a complementary fashion, to validate/calibrate the computational fluid dynamics turbomachinery code and improve understanding of the flow physics, were acquired. Detailed radial survey data which consisted of total pressure, total temperature, static pressure and flow angle were obtained at stations upstream and downstream of the rotor blade. Detailed velocity and turbulence profiles were obtained upstream of the rotor and used as the upstream boundary conditions for the numerical analysis. Calibrated flush-mounted hot film probes were used to measure wall shear stress on the hub and casing walls upstream of the rotor. The blade-to-blade shear-stress angle distributions were obtained at two axial locations on the rotor casing, using flush-mounted hot film probes. A numerical analysis conducted using a three-dimensional Navier-Stokes code was compared with the experimental results. Author

A91-56153

3D NAVIER-STOKES COMPUTATIONS IN TRANSONIC COMPRESSOR BLADINGS

V. COUAILLIER, A. M. VUILLOT (ONERA, Chatillon, France), and PH. VEYSSEYRE (SNECMA, Centre de Villaroche, Moissy-Cramayel, France) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 528-536. Research supported by DRET. refs
Copyright

This paper presents three-dimensional numerical simulations of compressor flows with a code solving the compressible averaged Navier-Stokes equations associated with a turbulence model. This code, developed at ONERA, will be included in the compressor blade design process at SNECMA. The numerical method is characterized by an explicit centered finite volume scheme, a multigrid acceleration technique, and a multi-domain technique.

Results obtained on two configurations are presented: a linear compressor cascade and an experimental wide-chord fan. Comparisons with experimental data are shown for the latter case. Author

A91-56154

THREE-DIMENSIONAL INVISCID COMPRESSIBLE CALCULATIONS AROUND AXIAL FLOW TURBINE BLADES

ANTOINE FOURMAUX (ONERA, Chatillon, France) and BERTRAND PETOT (SNECMA, Moissy-Cramayel, France) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 537-545. Research supported by DRET and Service Technique des Programmes Aeronautiques. refs
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The application of a three-dimensional method to the prediction of steady inviscid compressible flows in highly loaded turbine stator bladings is presented. The complete set of Euler equations is solved by a finite difference method using a time-marching two-step Lax-Wendroff algorithm. The treatment of the boundary conditions is based on the use of the characteristic relations. This technique offers a great versatility and allows to prescribe conditions close to the physics of flows encountered in turbomachines. The code was developed and adapted in order to build a three-dimensional design tool able to run on different types of turbine blade geometries. The H + C type of grid was chosen for industrial applications. Two applications to turbine nozzles are presented: the first one is a low pressure turbine vane with evolutive flow-path outer diameter; the second one is a high pressure inlet guide vane at transonic conditions. The strong radial evolution of pressure distribution and the trailing edge flow pattern are correctly predicted. Author

A91-56169

TRANSONIC FLOW THROUGH TURBINE CASCADES WITH 3 DIFFERENT PITCH TO CHORD RATIOS

RAINER KURZ (Hamburg, Universitaet der Bundeswehr, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 659-668. Research supported by BMVg. refs
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The paper deals with the influence of the pitch-to-chord ratio, the Mach number, and the Reynolds number on velocity distribution, total pressure losses, and flow angle of a transonic turbine cascade. Both experimental and numerically calculated data are used. A correlation for the base pressure loss is presented and used to calculate the total pressure loss from boundary layer data. Author

A91-56170

LIFTING SURFACE THEORY FOR SUPERSONIC THROUGH-FLOW FAN

M. NAMBA (Kyushu University, Fukuoka, Japan) and T. HANADA IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 669-677. refs
Copyright

The purpose of the present study is to predict analytically the steady performance of a supersonic through-flow fan in terms of design parameters. It is assumed that the fan cascade operates at supersonic axial velocity with small angle of attack, camber and thickness. A fully three-dimensional theory for this model is presented on the basis of the linearized lifting surface theory for a rotating annular cascade and a finite radial eigenfunction series approximation. Numerical results of the steady loading, total enthalpy and pressure ratios show that they heavily depend upon location of the leading edge Mach wave reflection point. Author

A91-56172**FLOW FIELD SIMULATION, WITHOUT PROPELLER, OF THE FLOW AROUND THE UDF GE 36 ENGINE AFTERBODY, AND UDF AFTERBODY STUDIES**

J. FONTAINE, J. COSTE, J. LEYNAERT (ONERA, Chatillon, France), E. MAINGRE, P. FESSOU, and R. FER (SNECMA, Melun, France) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 686-691.

Copyright

A test rig to simulate, without propeller, the flow around the afterbody of the UDF GE 36 engine is presented. The validity of the flow simulation is established by comparing rear pressures measured on the test rig and on the fan test bench in a wind tunnel. The thrust of the afterbody, which includes the engine exhaust annular nozzle, is measured. Pressures on afterbodies with complete or truncated plugs are compared. The test arrangement, based on grid systems, can be used to study the performance of any afterbody surrounded by nonuniform flow.

Author

A91-56174**CFD ANALYSIS OF THE X-29 INLET AT HIGH ANGLE OF ATTACK**

R. H. TINDELL and W. G. HILL, JR. (Grumman Corp., Bethpage, NY) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 703-711. refs

Copyright

This paper presents the results of a computational fluid dynamics (CFD) analysis of the X-29 forebody-inlet flowfield at high angles of attack and low speed. The goal of the work was to define the inlet performance and flow patterns, and identify any fluid dynamic mechanisms that could cause an unacceptable loss of performance or stability in the very high angle-of-attack operating regime, $\alpha = 50$ deg to 90 deg, which has not yet been evaluated. External flow calculations to define inlet/forebody characteristics are done using a panel method, and internal duct calculations employ a Navier-Stokes code. External and internal flow calculations are compared with wind tunnel data, describing static and total pressure characteristics across a broad range of angle of attack. Computed inflow velocity patterns are also described and discussed. Results of a calculation describing inlet flowfield improvements provided by a slotted duct demonstrate the application of CFD to efficiently screen innovative design modifications.

Author

A91-56175**ACCURATE PREDICTION OF THREE DIMENSIONAL INTAKE FLOW**

A. R. ASLAN (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium; Istanbul Technical University, Turkey) and R. GRUNDMANN (Institut von Karman de Dynamique des Fluides, Rhode-Saint-Genese, Belgium) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 712-723. refs

(Contract BMVG-T/RF-42/G022/G1412)

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Laminar and turbulent 3D subsonic flows in ducts are analyzed for viscous incompressible and compressible fluids by an accurate and economic prediction method. The flow field is modeled using the parabolized Navier-Stokes (PNS) equations written for general curvilinear coordinates. In the absence of separation, this model enables a space marching procedure in the main stream direction, which reduces the computer memory and time consumption considerably compared to the needs for solving the full Navier-Stokes equations. An a priori determined inviscid pressure field is used to take into account the inviscid upstream influences, normally not considered in the PNS equations. Computations are performed for developing laminar and turbulent flows in a large

variety of duct geometries, including a generic aircraft intake with variable cross-sections for various Reynolds numbers and inlet Mach numbers in the subsonic range. Comparisons of the results with available experimental and numerical data demonstrate the reliability of the method.

Author

A91-56178**PREDICTION METHODS FOR SUPERSONIC INLETS**

P. DUVEAU and R. THEPOT (ONERA, Chatillon, France) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 738-745. refs

(ONERA, TP NO. 1991-128) Copyright

A simple and fast semi-empirical program based upon data banks allows the calculation of two-dimensional inlets performances, such as pressure recovery and mass flow ratios, with an acceptable accuracy. Two-dimensional solvers are also used in order to obtain details about flowfields and pressure distribution particularly at the internal cowl surface. Some comparisons with experiment give a rather good agreement, though these codes mispredict the position of the normal shock in the diffuser. These methods are found to converge rapidly for supersonic inlet operation. For subcritical inlet operation, however, convergence to steady state is slow. Calculations with a three-dimensional Navier Stokes solver have also been performed.

Author

A91-56179**MACH 5 TURBO-RAMJET INLET DESIGN AND PERFORMANCE**

J. L. BENSON and L. D. MILLER (Lockheed Aeronautical Systems Co., Burbank, CA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 746-753. refs

Copyright

The engineering process used in the selection of the inlet for a Mach 5 turbo-ramjet powered cruise vehicle is described. This process involved assessing the impact that critical propulsion system variables had on the vehicle's overall performance. These studies resulted in the selection of a relatively low internal contraction ratio, two dimensional variable geometry mixed compression inlet design. The performance levels computed for this design over the operating Mach regime are presented, specifically inlet total pressure recovery, inlet mass flow ratio, and inlet spillage drag are shown. The inlet's aerodynamic surface development is also discussed. The primary tool used was the Method of Characteristics code with a boundary layer displacement thickness correction. Also a parabolized Navier Stokes code was used to aide in the design of the boundary layer bleed system. A large scale model of this design has been fabricated, and subsequently tested as part of a joint Lockheed-NASA research program. Preliminary test results are discussed and comparisons with theory presented.

Author

A91-56193**SUBSONIC AND SUPERSONIC MIXING AND COMBUSTION ENHANCEMENT**

GABRIEL D. ROY (U.S. Navy, Office of Naval Research, Arlington, VA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 877-885. refs

Results are reported from a conceptual evaluation of higher speed, long range supersonic combustion ramjets. This program was focused to determine the turbulent structure, size scales, intensities and rates of heat and mass transfer of compressible subsonic and supersonic shear layer mixing flows, with and without combustion. The present paper will focus on supersonic shear layer mixing and combustion enhancement. The studies showed that heat release tends to inhibit the mixing of shear layers; however, three-dimensional excitation at subharmonics of the shear

layer, and streamwise vorticity stirring by lobbed splitter plates, have been found to increase mixing and combustion. The supersonic shear layers are found to be stable, and their growth decreases as the convective Mach number (Mc), a newly defined parameter, increases. Vortex generators increase the growth rate of supersonic shear layers by about 30 percent, whereas shock impingement has very little effect. Nonaxisymmetric nozzles and inlets have shown to enhance mixing and combustion of supersonic coaxial flows. Author

A91-56196

INSTABILITIES IN CONFINED SUPERSONIC MIXING LAYERS

G. A. SULLINS, H. E. GILREATH, L. A. MATTES (Johns Hopkins University, Laurel, MD), P. S. KING, and J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 906-916. refs

(Contract N0039-89-C-0001)

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Experimental investigations of the mixing of parallel supersonic streams have been performed. The development of the turbulent shear layer was typically a gradual process, with a spreading angle of approximately 2 deg. However, for certain conditions, the onset of large-scale instability and increased growth were apparent. Another part of the study examined the stability characteristics of confined parallel streams using linear stability theory. Results showed that the mixing zone between confined streams was indeed unstable to large-scale perturbations, and that it was possible to define the conditions under which the instability could be maximized. A two-dimensional linear stability code has been developed to continue to investigate the stability of parallel supersonic streams in close association with the present experiments. Author

A91-56201

STALLED FLOW BEHAVIOUR IN AN AXIAL FLOW COMPRESSOR

G. ZHANG (South China University of Technology, Guangzhou, People's Republic of China) and J. W. RAILLY (Birmingham, University, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 952-960. refs

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This paper describes an experimental investigation of the stalled flow behavior in a single-stage axial compressor, and the subsequent calculation aimed at obtaining the axisymmetric compressor's characteristics. Velocity and pressure measurements in both absolute and relative flow fields during rotating stall are carried out using the phase-lock average and shaft-encoder method, respectively. It is shown that a stall cell is an intense flow-interaction area with both cross flow and rapid variations of flow velocity and pressure at its boundaries. In deep stall, the compressor exhibits large hysteresis between the local static pressure rise and flow rate. The time lag of this hysteresis is found to be of approximately three times of the fluid pass-through time, based on the mean flow velocity. Using this value of time lag, a near single-valued, quasi-steady static pressure rise coefficient is obtained. Author

A91-56220

DEVELOPMENT OF UNDEREXPANDED SONIC JET EXHAUSTING FROM THE CONVERGENT NOZZLE OF AN AXISYMMETRIC AFTERBODY CONFIGURATION

N. B. MATHUR (National Aeronautical Laboratory, Bangalore, India) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1116-1122. refs

Copyright

Experimental investigations were carried out to study the

development of underexpanded sonic jets and the effect of jet plume boundary shape on the pressure drag characteristics of an axisymmetric afterbody configuration. Experiments were conducted in the free stream Mach number range of 0.6 to 1.20 with the Reynolds number varying from 7.5×10^6 to the 6th to 13×10^6 to the 6th (based on the length of the model) keeping the model at zero degree of incidence. The jet pressure ratio was varied from 1 to about 6. The jet at the nozzle exit was sonic throughout these tests. Experimental results show that the jet plume displacement effect on the afterbody flow is predominant at transonic free stream Mach numbers while the jet plume entrainment effect is predominant at subsonic/high subsonic free stream Mach numbers. The resultant effect of the increase in initial inclination of jet plume (with the increase in jet pressure ratio) caused favorable jet-free stream interactions causing the decrease in afterbody pressure drag. Jet plume-induced base pressure for the axisymmetric air nozzle correlated with the jet induced effects of other axisymmetric nozzles by matching the thrust coefficient based on the nozzle lip condition. Author

A91-56371

DISSOCIATION-VIBRATION COUPLING APPLICATION TO HYPERSONIC NOZZLE FLOWS

C. FLAMENT (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1991, p. 67-78. refs

Copyright

A method giving the direct effect of molecule dissociation on their vibrational energy relaxation from the dissociation reaction rate is presented. A new dissociation-vibrational coupling is enhanced by this method from the incomplete model of Park (1988) and is employed for the computation of two hypersonic nozzle flows. The coupling has only a small effect on the flow field, but it demonstrates that the dissociation and recombination phenomena involve very high vibrational levels. R.E.P.

A91-56432

BOUNDARY LINEAR INTEGRAL METHOD FOR COMPRESSIBLE POTENTIAL FLOWS

Z. FANG and I. PARASCHIVOIU (Ecole Polytechnique, Montreal, Canada) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 13, Sept. 20, 1991, p. 699-711. refs

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A boundary linear integral method based on Green function theory has been developed to solve the full potential equation for subsonic and transonic flows. In this integral method, potential values in the flow region are determined by potential values represented by boundary integrals and a volume integral. The boundary potential values are obtained by implementing the boundary integrals along boundary segments where a linear potential relation is assumed. The volume integral is evaluated in a grid generated by finite element discretization. The volume integral is evaluated only outside the body. Therefore there is no extra boundary treatment required for evaluation of the volume integral. The source term is assumed to be constant in an element integral volume. The volume integral needs to be evaluated only once and can be stored in computer memory for further usage. Author

A91-56433* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A SPECTRAL COLLOCATION METHOD FOR COMPRESSIBLE, NON-SIMILAR BOUNDARY LAYERS

C. D. PRUETT and CRAIG L. STREETT (NASA, Langley Research Center, Hampton, VA) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 13, Sept. 20, 1991, p. 713-737. refs

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An efficient and highly accurate algorithm based on a spectral collocation method is developed for numerical solution of the compressible, two-dimensional and axisymmetric boundary layer equations. The numerical method incorporates a fifth-order, fully implicit marching scheme in the streamwise (timelike) dimension

and a spectral collocation method based on Chebyshev polynomial expansions in the wall-normal (spacelike) dimension. The spectral collocation algorithm is used to derive the nonsimilar mean velocity and temperature profiles in the boundary layer of a 'fuselage' (cylinder) in a high-speed (Mach 5) flow parallel to its axis. The stability of the flow is shown to be sensitive to the gradual streamwise evolution of the mean flow and it is concluded that the effects of transverse curvature on stability should not be ignored routinely. Author

A91-56548

NUMERICAL SIMULATIONS OF THREE-DIMENSIONAL SUPERSONIC FLOWS

T. PASSOT (Observatoire de la Cote d'Azur, Nice, France; Arizona, University, Tucson) and A. POUQUET (Observatoire de la Cote d'Azur, Nice, France) *European Journal of Mechanics, B/Fluids* (ISSN 0997-7546), vol. 10, no. 4, 1991, p. 377-394. Research supported by CNRS. refs
(Contract DRET-500-276; F49620-86-C-0130; NSF DMS-87-03397)
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Results of a numerical study of homogeneous flows in the supersonic regime for fully developed turbulence and 3D geometry are reported. The code employed is based on the collocation method and uses a grid of 128 uniformly distributed points. At moderate Reynolds numbers, the flow does not differ substantially from the 2D case, except for the development of regions of low density in three dimensions, and well into the subsonic regime, for the faster decline in time of the Mach number. V.L.

A91-56549

CALCULATION OF THE VORTEX SHEETS DOWNSTREAM OF PROPELLER BLADES USING NON-LINEAR THEORY

C. PELLONE (Grenoble, Centre de Recherches et d'Essais de Machines Hydrauliques, Saint-Martin-d'Heres, France) *European Journal of Mechanics, B/Fluids* (ISSN 0997-7546), vol. 10, no. 4, 1991, p. 407-426. refs
(Contract DRET-87-286)
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The paper presents the results of a long-term effort carried out in France, which resulted in the development of a numerical method which can be used as a practical tool in both steady and unsteady flow problems associated with marine propellers. In this study, calculation of the wake vortex sheet downstream of the propeller blades is achieved by means of two iterative procedures: either a Lagrangian method applied to the steady case or a relaxation method. Comparative results of the two methods are given. The introduction of hub highlights its significant effect on global results (thrust and torque) as well as its influence on sheets rolling up. Comparisons of numerical results with experimental data are presented. Moreover, this subcavitating program has been constructed in such a way as to permit direct extension to the problem of three-dimensional unsteady partially cavitating flows. Author

A91-56783

VALIDATION OF TRANSONIC TURBULENT FLOWS PAST DELTA WING CONFIGURATIONS

A. HILGENSTOCK (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) *Aeronautical Journal* (ISSN 0001-9240), vol. 95, Aug.-Sept. 1991, p. 219-230. refs
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The turbulent flow around a delta wing at incidence is simulated numerically using a finite-volume Navier-Stokes method. The numerical simulation makes use of a simple algebraic turbulence model. The influence of grid refinement is investigated. The more realistic wing-body configuration with round leading edge is used to discuss the influence of the position of the transition line and to compare experimental and numerical data to validate the numerical method. The topological structure of the flow is discussed. An explanation is given for the low particle density

area close to the primary vortex as it is visualized by laser light-sheet technique in the experiment. Results for a close coupled delta-wing-canard configuration are discussed. Author

A91-56784

THE EFFECTS OF ICING ON THE DYNAMIC RESPONSE OF THICK AEROFOILS

C. A. LUCAS (Australian Artificial Intelligence Institute, Carlton, Australia) *Aeronautical Journal* (ISSN 0001-9240), vol. 95, Aug.-Sept. 1991, p. 231-240. refs
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Vibration of a flexible wing strut of 30 percent thickness/chord ratio occurred during icing trials of a commuter aircraft. Wind tunnel testing demonstrated that, over a limited range of incidence angle, the flow around the flexible strut was dominated by a long separation bubble that periodically 'burst' and reattached. A high-speed film was made using smoke visualization of the flow around a 40 percent rigid scale model of the strut. This was used to correlate the unsteady pressure field, measured at 18 points around the profile, with the dynamic behavior of the separation bubble. Author

A91-57002

SOME AERODYNAMIC ASPECTS OF WINGS NEAR GROUND

DIETER STEINBACH and KLAUS JACOB (DLR, Goettingen, Federal Republic of Germany) *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), vol. 34, Aug. 1991, p. 56-70. refs

Experimental and theoretical results of a research project on fundamental aerodynamic aspects of high-lift airfoils and finite wings near ground are presented. It is concluded that the flow around airfoils and wings may be changed considerably when flying near the ground, especially at high lift. For 2D flows the reflected image of the bounded vortex system changes the basic flow in the vicinity of the airfoil, reducing the local foil velocities. For 2D flows and wings with high aspect ratios, the negative effects of ground predominate. For 3D flows around finite wings, there is an additional effect of the reflected images of the trailing vortices, inducing upward velocities at the wing, increasing the lift, and reducing the induced drag. At high aspect ratios and high lift the ground effect may be negative with respect to lift, but still positive with respect to lift-drag ratio. O.G.

A91-57005

A FORMULA TO ESTIMATE LIFT CURVE SLOPES OF ELLIPTIC WINGS IN GROUND EFFECT

TAKESHI SUGIMOTO (Tokyo, University, Japan) *Japan Society for Aeronautical and Space Sciences, Transactions* (ISSN 0549-3811), vol. 34, Aug. 1991, p. 101-105. refs

A closed form solution is analytically derived for the lifting surface integral equation, which takes account of ground effect for a large ground clearance. The following assumptions are made: (1) the wing geometry is elliptic, (2) the pressure difference distribution is concentrated along the straight quarter chord; and (3) the loading is elliptic. By using the collocation method, the final result is obtained as a formula by which one can estimate lift curve slopes of elliptic wings in ground effect throughout the aspect ratio range, from infinite to zero. Limiting forms are also derived for two-dimensional and very slender wings. Comparisons of limiting forms with known analytic results show good agreement to an order of the reciprocal of square of nondimensional altitude. Author

N91-31080 Oklahoma Univ., Norman.

COMPUTATIONAL ANALYSIS OF HYPERSONIC FLOWS PAST ELLIPTIC-CONE WAVERIDERS Ph.D. Thesis

BOK-HYUN YOON 1990 307 p
Avail: Univ. Microfilms Order No. DA9119183

A comprehensive study for the inviscid numerical calculation of the hypersonic flow fields past a class of elliptic-cone derived waveriders is presented. The theoretical background associated with hypersonic small disturbance theory (HSDT) is reviewed. Several approximation formulas for the waverider compression

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surface are established. A computational fluid dynamics (CFD) algorithm is used to calculate flow fields for the on-design case and a variety of off-design cases. The results are compared with (HSDT), experiment, and other CFD results. The unknown flow patterns that were discovered show the power and utility of CFD for investigating novel hypersonic configurations such as waveriders. Dissert. Abstr.

N91-31082*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

USER'S GUIDE TO A SYSTEM OF FINITE-ELEMENT SUPERSONIC PANEL FLUTTER PROGRAMS

CHRISTINE L. WOOLLEY and JOHN T. BATINA Jul. 1991 54 p
(NASA-TM-104109; NAS 1.15:104109) Avail: NTIS HC/MF A04 CSCI 01/1

The utilization and operation of a set of six computer programs for the prediction of panel flutter at supersonic speeds by finite element methods are described. The programs run individually to determine the flutter behavior of a flat panel where the finite elements which model the panel each have four degrees of freedom (DOF), a curved panel where the finite elements each have four DOF, and a curved panel where the finite elements each have six DOF. The panels are assumed to be of infinite aspect ratio and are subjected to either simply-supported or clamped boundary conditions. The aerodynamics used by these programs are based on piston theory. Application of the program is illustrated by sample cases where the number of beam finite elements equals four, the in-plane tension parameter is 0.0, the maximum camber to panel length ratio for a curved panel case is 0.05, and the Mach number is 2.0. This memorandum provides a user's guide for these programs, describes the parameters that are used, and contains sample output from each of the programs. Author

N91-31084# National Aerospace Lab., Amsterdam (Netherlands). Aerodynamics Div.

A EUROPEAN COLLABORATIVE INVESTIGATION OF THE THREE-DIMENSIONAL TURBULENT SHEAR LAYERS OF A SWEEP WING

B. VANDENBERG 19 Sep. 1988 24 p Presented at the AGARD Fluid Dynamics Panel Symposium on Fluid Dynamics on Three-Dimensional Turbulent Shear Flows and Transition, Cesme, Turkey, 3-6 Oct. 1988 Previously announced as N90-10380 (NLR-MP-88054-U; GARTEUR-AD(AG07)-TP048; ETN-91-99655; AD-B153469L) Avail: NTIS HC/MF A03

An extensive and detailed experiment in progress is described on the turbulent shear layers of a swept wing. The measurements comprise both the upper and lower wing surface boundary layer as well as the three dimensional near wake behind the wing. Starting from required viscous flow properties, a wing geometry was designed by flow calculations. The theoretical wing design was checked by pilot model tests. The results suggest that the viscous flow in this experiment may become an interesting test case for turbulence models for three dimensional shear flows. The measurements in the turbulent shear layers comprise mean flow quantities, skin friction data and the six Reynolds stress tensor components. To establish the measurement accuracy, several data checks were performed, including independent tests with similar models in two different wind tunnels. ESA

N91-31085# Max-Planck-Inst. fuer Stroemungsforschung, Goettingen (Germany, F.R.).

THE EFFECT OF JET BLEED ON BASE PRESSURE DISTRIBUTION, SHEDDING FREQUENCY, AND MEAN VELOCITY PROFILES IN THE WAKE BEHIND A TWO-DIMENSIONAL BLUNT MODEL

V. L. ZHDANOV and H. ECKELMANN Jun. 1990 37 p
Sponsored in part by Max-Planck-Gesellschaft
(MPIS-12/1990; ISSN-0436-1199; ETN-91-99738) Avail: NTIS HC/MF A03

A two dimensional body with a semicircle front followed by a parallel sided body with a blunt trailing edge is investigated at a free stream velocity of 14 m/s in an open return wind tunnel with

a cross section of 280 by 1400 square mm. The cord length, base height and spanwise width of the body are 200 mm, 40 mm and 280 mm, respectively. By means of a slot in the near surface of the body a base bleed is achieved. The slot width is changed from 0.75 mm to 3.8 mm, and the bleed coefficient varies between zero and 0.24. Base pressure and Strouhal number distributions as well as mean velocity profiles in the wake of the body are presented. ESA

N91-31087# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Kommunikationssysteme und Antriebe.

A SHOCK-FITTING ALGORITHM FOR THE SIMULATION OF INVISCID FLOWS IN CHEMICAL NON-EQUILIBRIUM

M. PFITZNER 30 Jan. 1990 33 p Presented at the 12th ICNMF, Oxford, England, 1990
(MBB-UK-0131-90-PUB; OTN-033083; ETN-91-99756) Avail: NTIS HC/MF A03

An upwind finite difference algorithm based on the integration of the quasi conservative Euler equations for the simulation of inviscid flow in chemical non-equilibrium is described. Shock fitting is applied to deal with the strong bow shock present in hypersonic flows. Post correction techniques are used. An explicit Runge-Kutta time stepping scheme is applied with the chemical source terms treated point implicitly where necessary. Convergence is accelerated using a local time step and enthalpy correction. In the supersonic part of the flow field the pseudo space marching technique is applied. The algorithm is implemented in two dimensional and three dimensional codes. Results of several test cases are presented. ESA

N91-31088# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.

VISCOS EFFECTS

E. H. HIRSCHL 1 Feb. 1991 38 p Presented at Space Course 1991, Aachen, Fed. Republic of Germany, 20 Feb. 1991
(MBB-FE202/S/PUB/441; ETN-91-99764) Avail: NTIS HC/MF A03

Viscous effects play a large role in hypersonic aerothermodynamics, especially for airbreathing cruise vehicles. Four basic classes of viscous hypersonic flow are identified and discussed. Their influence on aerothermodynamic vehicle design and performance is sketched. The fact that viscous effects must be seen in the broader context of diffusive context of diffusive transport mechanisms is illustrated. Selected phenomena are discussed in more detail and qualitative and quantitative results are given. ESA

N91-31092# Office National d'Etudes et de Recherches Aeronautiques, Paris (France). Direction de l'Aerodynamique.

EXPLOITATION OF OAT15A PROFILE TESTS IN THE T2 WIND TUNNEL: EXPERIMENTAL DETERMINATION OF THE WAVE DRAG Final Summary Report [EXPLOITATION DES ESSAIS DU PROFIL OAT15A DANS LA SOUFFLERIE T2: DETERMINATION EXPERIMENTALE DE LA TRAINEE D'ONDE. RAPPORT DE SYNTHESE FINAL]

H. BEZARD Jul. 1990 46 p In FRENCH
(Contract DRET-89-34-001)
(ONERA-RSF-88/1685-AY-158-A; ETN-91-99929) Avail: NTIS HC/MF A03

Results and exploitation of OAT15A profile tests in the T2 wind tunnel with laser velocimetry flow analysis are presented with the aim of experimentally determining the wave drag on the profile. The shock is determined for different contours by integrating the amount of movement. The influences of contour integrations and the precision on velocity measurements are studied. Comparisons are carried out with different viscous computation methods. ESA

N91-31093# Office National d'Etudes et de Recherches Aérospatiales, Paris (France). Direction de l'Aérodynamique.
VALIDATION OF TWO DIMENSIONAL DRAG PREDICTION METHODS Final Summary Report [VALIDATION DES METHODES DE PREVISION DE LA TRAINEE EN BIDIMENSIONNEL. RAPPORT DE SYNTHESE FINAL]
 A. M. RODDE Mar. 1990 40 p In FRENCH
 (ONERA-RSF-85/1685-AY; ETN-91-99930) Avail: NTIS HC/MF A03

Drag on different profiles is analyzed and results are compared to other research tests. Three profiles are studied: the OAT15A, for which detailed results obtained in transonic wind tunnels are used; the NACA0012 and RAE2822 profiles, for which published tests results and computations are used. The potential non conservative strong coupling method is shown to obtain for the most part comparable results to NASA research. ESA

N91-31094# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).
ATSF SUPERSONIC AIRCRAFT INTAKE. REVIEW OF THE ANALYSES OF SOME PARTICULAR PROBLEMS, TECHNICAL SUMMARY [ENTREES D'AIR POUR L'AVION SUPERSONIQUE ATSF. REVUE DES MOYENS D'ETUDES ET DE QUELQUES PROBLEMES PARTICULIERS. RAPPORT TECHNIQUE DE SYNTHESE]
 C. SANS Aug. 1990 96 p In FRENCH
 (ONERA-RTS-134/2149-AY-640-A; ETN-91-99931) Avail: NTIS HC/MF A05

A survey and application examples of codes (semi-empirical and numerical) for computing internal flow in two dimensional supersonic air intakes are presented. Air intake drag reduction and flow stability (effects of pumping) are considered. Industrially proposed air intake definitions are analyzed. Existing test methods are reviewed. ESA

N91-31096# Office National d'Etudes et de Recherches Aérospatiales, Toulouse (France). Dept. d'Etudes et de Recherches en Aerodynamique.
STUDY OF THE FLOW AROUND THE GARTEUR AD/AG07 WING: FIRST F2 TEST CAMPAIGN RESULTS Final Report [ETUDE DE L'ECOULEMENT AUTOUR DE L'AILE GARTEUR AD/AG07: RESULTATS DE LA PREMIERE CAMPAGNE D'ESSAIS AF2]
 C. GLEYZES Jun. 1990 134 p In FRENCH
 (Contract STPA-89-95-004-52)
 (ONERA-DERAT-37/5025-26; ETN-91-99941) Avail: NTIS HC/MF A07

Three dimensional shear flow around the Garteur AD/AG07 wing was studied. Attention was paid to the preparation, model equipment (pneumatic and electric), and development of different measurement methods. The study focused principally on a parametric study to define the final configuration for final tests. The transition triggering system performance was verified. Wall pressure measurements and friction direction measurements in an incidence region around the nominal theoretic incidence (0.5 deg) were made. Three dimensional boundary layer soundings were taken within scanners installed on the model in the 0.5 deg configuration. ESA

N91-31098# Association Aeronautique et Astronautique de France, Paris.
RADAC MODEL DEFORMATION MEASUREMENT SYSTEM: FIRST RESULTS AT THE F1 WIND TUNNEL [DISPOSITIF RADAC DE MESURE DES DEFORMATIONS DE MAQUETTE: PREMIERS RESULTATS EXPERIMENTAUX DANS LA SOUFFLERIE F1]
 B. LAMISCARRE, B. SIDORUK, C. CASTAN, and M. BAZIN (Office National d'Etudes et de Recherches Aérospatiales, Paris, France) 1989 21 p In FRENCH Presented at the 26th Colloque d'Aérodynamique Appliquée, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A91-19595
 (AAAF-NT-89-03; ISBN-2-7170-0936-1; ISSN-0243-0177;

ETN-91-99944) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

The RADAC (French acronym for altitude and deformation reconstruction) measurement system enables determination of the model and test assembly deformations under aerodynamic forces. The principles of stereo reconstruction of three dimensional shapes are described. Tests results and first results obtained during qualification tests in the F1 pressurized wind tunnel are presented. ESA

N91-31099# Association Aeronautique et Astronautique de France, Paris.
CONDITIONAL SAMPLING [LE PRELEVEMENT CONDITIONNEL]
 C. ARMAND and R. SELVAGGINI (Office National d'Etudes et de Recherches Aérospatiales, Modane, France) 1989 21 p In FRENCH Presented at the 26th Colloque d'Aérodynamique Appliquée, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A90-21047
 (AAAF-NT-89-04; ISBN-2-7170-0937-X; ISSN-0243-0177; ETN-91-99945) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

A conditional sampling method to overcome parametric uncertainties in wind tunnel experimental conditions is presented. The method consists of permanently measuring the parameter to be regulated and allows measurement of pressure distribution on wing configurations to be carried out precisely since the measurement are synchronized and acquired in desired conditions. The method is applied to two tests: wing pressure measurement and aerodynamic measurements on a demi-model. ESA

N91-31100# Association Aeronautique et Astronautique de France, Paris.
LASER VELOCIMETRY AT THE CEAT AERODYNAMIC GROUP: APPLICATION TO UNSTEADY MEASUREMENTS ON A FLUID FLAP PROFILE [LA VELOCIMETRIE LASER AU GROUPE AERODYNAMIQUE DU CEAT: APPLICATION AUX MESURES INSTATIONNAIRES SUR UN PROFIL A VOLET FLUIDE]
 J. HUMBERTCLAUDE and P. DUFOUR 1989 44 p In FRENCH Presented at 26th Colloque d'Aérodynamique Appliquée, Toulouse, France, 23-25 Oct. 1990
 (AAAF-NT-89-05; ISBN-2-7170-0938-8; ISSN-0243-0177; ETN-91-99946) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 30 francs

The use of laser velocimetry to analyze unsteady conditions (helicopter profile or canard surface incidence oscillation) is discussed. A solution that can be used in periodic test cases is addressed. A synchronization housing triggers conditional acquisition during each cycle. An application of results obtained in a test campaign on a pulsed fluid flap profile is presented. ESA

N91-31101# Association Aeronautique et Astronautique de France, Paris.
LOW LEVEL TURBULENCE DETECTION BY A LASER VELOCIMETRY TECHNIQUE: APPLICATION TO TRANSONIC FLOWS [DETECTION DE BAS NIVEAUX DE TURBULENCE PAR UNE TECHNIQUE DE VELOCIMETRIE LASER: APPLICATION AUX ECOULEMENTS TRANSSONIQUES]
 V. MERCIER, P. SZEGE, R. LEBLANC, M. RIETHMULLER, and R. DECUYPERE (Ecole Royale Militaire, Brussels, Belgium) 1989 17 p In FRENCH Presented at 26th Colloque d'Aérodynamique Appliquée, Toulouse, France, 23-25 Oct. 1989 (Contract DRET-87-1187)
 (AAAF-NT-89-07; ISBN-2-7170-0940-X; ISSN-0243-0177; ETN-91-99948) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

The development of a laser velocimetry technique to detect

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the boundary layer transition in transonic flow is described. The turbulence measurement relies on analyzing the number of particles passing from one spot to another and more precisely on the correlation between them. The minimum turbulence detectable by LDV (Laser Doppler Velocimetry) in percentage, approaches the percentage given by LTV (Laser Transit Velocimetry) for certain applications. A mathematical model confirms the sensitivity of the obtained characteristic parameter. The method is transposed for transonic wind tunnel measurements. ESA

N91-31104# Association Aeronautique et Astronautique de France, Paris.

AIRFOIL-VORTEX INTERACTION: UNSTEADY WALL PRESSURE MEASUREMENT [INTERACTION ENTRE UN TOURBILLON ET UN PROFIL: MESURE DE PRESSIONS PARIETALES INSTATIONNAIRES]

J. L. PEUBE, B. FERRET, and S. GABARD (Poitiers Univ., France) 1989 27 p In FRENCH Presented at the 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A91-19593

(AAAF-NT-89-13; ISBN-2-7170-0946-9; ISSN-0243-0177; ETN-91-99954) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 30 francs

Problems encountered at the metrology level of wall pressure and different solutions studied for correcting the measurement component are presented. A theoretic study to determine the optimal position of a mechanical restrictor along the length of a pneumatic connecting tube is given. Experimental results from unsteady pressure measurements are presented. ESA

N91-31105# Association Aeronautique et Astronautique de France, Paris.

BOUNDARY LAYER TRANSITION DETECTION AND MEASUREMENT METHODS AT CERT/DERAT [MOYENS DE DETECTION ET DE MESURES DE LA TRANSITION DE LA COUCHE LIMITE UTILISES AU CERT/DERAT]

J. C. JUILLEN and D. ARNAL (Centre d'Etudes et de Recherches, Toulouse, France) 1989 40 p In FRENCH Presented at the 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A91-19592

(AAAF-NT-89-14; ISBN-2-7170-0947-7; ISSN-0243-0177; ETN-91-99955) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 30 francs

A nonexhaustive list of methods to detect and measure boundary layer transition is prepared. Results that can be expected from each method and various application examples and results are given: swept wing transition in wind tunnel; transition in incompressible flow on a flat plate in wind tunnel (hot wire and microphone); transonic flight transition; hypersonic swept cylinder transition; and liquid crystal visualization. ESA

N91-32049# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).

SUPERSONIC INLET FLOW COMPUTATIONS WITH CAVITY

SHINICHI KURODA and KOZO FUJII (Tokyo Univ., Japan) In National Aerospace Lab., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 127-132 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

The supersonic inlet plays a partial or whole role in the air compression process of supersonic/hypersonic air-breathing engines and is a key factor in engine performance. The flow fields of a supersonic inlet which has a bleed chamber are simulated using a zonal method. The zonal method can connect zones with high accuracy and permit the movement of discontinuities across the zonal boundary. Author

N91-32050# National Aerospace Lab., Tokyo (Japan).

NUMERICAL SIMULATION ANALYSIS OF SIDEWALL EFFECTS IN TWO-DIMENSIONAL WIND TUNNELS

JUNICHI MIYAKAWA, MIHO SHIMIZU, SUSUMU TAKANASHI, and

KANICHI AMANO (Japan Aircraft Development Corp., Tokyo.) In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 133-140 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

Computational aerodynamics has evolved to be a practical design tool comparable to wind tunnel testing, and it has played an important role in actual aircraft design stages. In addition to the design tool, there is another important field of application for computational fluid dynamics, which is as an analytical tool in wind tunnel testing. Sidewall effects in 2-D wind tunnel testing are described, and aerodynamic effects in 2-D are evaluated. Author

N91-32051# Institute of Computational Fluid Dynamics, Tokyo (Japan).

THE THREE DIMENSIONAL NAVIER-STOKES SIMULATIONS OF FLOW OVER A WING WITHOUT ANY TURBULENT MODELLING

TAKUYA SAKURAGI, KATUYA ISII, and KUNIO KUWAHARA (Tokyo Univ., Japan) In National Aerospace Lab., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 141-146 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

Direct simulation without any turbulence models has become an effective method to study 3-D unsteady flow fields at high Reynolds numbers. This progress was made possible by the speed and memory capabilities of present-generation supercomputers and the development of improved computational algorithms and techniques. The unsteady shock-boundary interaction in the viscous transonic flow over the ONERA-M6 wing attached to a wall is investigated using a finite difference approximation of the 3-D Navier-Stokes equations. For this purpose, the LU-AU factorization method was used with a Chakravarthy and Osher type total variation diminishing (TVD) scheme in the explicit term, and got the time-average of the unsteady flow field without using any turbulent eddy viscosity models. As the number of grid points gets large, the CP-curves of the time-average become close to the results of the experiment. Author

N91-32065# National Aerospace Lab., Tokyo (Japan).

ANALYSIS OF THE AERODYNAMIC PERFORMANCE OF COUNTER-ROTATING PROPELLER BY MEANS OF VORTEX LATTICE METHOD

SHIGERU SAITO and YASUHIRO MIZOBUCHI (Tokyo Univ., Japan) In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 227-232 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

Aerodynamic performance of a counter rotating propeller was calculated by means of Vortex Lattice Method. The new wake system of each rotor was constructed using a prescribed wake model by Kocurek-Berkowitz-Harris, which is well known as an empirical wake system of helicopter rotor with low aspect ratio blades. The vortex filaments including a blade tip vortex were treated as vortex tubes with the finite vortex core in order to avoid the numerical divergence in the calculation. The calculated results for a single rotating propeller have shown good agreement with experimental results in the subsonic speed range. The results for counter rotating propeller were compared with those by Local Circulation Method and wind tunnel test results and shown good correlation. Author

N91-32066# National Aerospace Lab., Tokyo (Japan).

NAVIER-STOKES ANALYSIS FOR FLOWFIELD AROUND HOVERING ROTOR

TAKASHI AOYAMA, KEIJI KAWACHI, and SHIGERU SAITO In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 233-238 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

The 3-D Navier-Stokes equations are solved to analyze the flow field around a blade tip of a hovering rotor. The eddy viscosity is calculated by using the Baldwin-Lomax zero equation turbulence

model and the q-w two equation turbulence model developed by Coakley. An implicit finite difference method is used to solve the equations and the algebraic method is adopted to generate the grids. The effect of wake outside of the grid is taken into consideration by correcting the equivalent geometric angle of attack along the blade radius. Its value is estimated by using prescribed vortex lattice method (VLM) or Local Circulation Method (LCM). The pressure distribution on blade surface predicted by the present method are similar to other theoretical results and are in reasonable agreement with the experimental data. In addition, the present results are compared with the results calculated by the Euler code. In transonic cases, some differences are shown in the results.

Author

N91-32072# Wright Lab., Eglin AFB, FL. Armament Directorate.

THIN LAYER NAVIER-STOKES SOLUTIONS FOR TRANSONIC MULTIBODY INTERFERENCE Interim Report, Aug. 1990 - Jan. 1991

PRISCA L. LYNCH and MAGDI H. RIZK Mar. 1991 11 p
Previously announced in IAA as A91-21357
(Contract AF PROJ. 2567)
(AD-A234252; WL/MN-TR-91-23) Avail: NTIS HC/MF A03
CSCL 20/4

A thin layer, Navier Stokes flow solver was used to predict the aerodynamics about interfering bodies. Surface pressure distributions compared very well with available experimental data for freestream Mach numbers between 0.60 and 1.20 at an interbody separation distance of 0.8 diameters. Five separate interference regions were identified which contribute to the total interference force, which was an attractive force for all cases investigated. In general, the level of interference increases with increasing free stream Mach number, and decreases with increasing separation distance.

GRA

N91-32076# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Mathematische Verfahren und Datentechnik.

DETERMINATION OF AERODYNAMIC CHARACTERISTICS FROM ATTAS FLIGHT DATA GATHERING FOR GROUND-BASED SIMULATOR

RAVINDRA JATEGAONKAR (Technische Univ., Brunswick, Germany, F.R.) May 1991 58 p
(DLR-FB-91-15; ISSN-0939-2963; ETN-91-90045) Avail: NTIS
HC/MF A04; DLR, Wissenschaftliches Berichtswesen, VB PL DO,
Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC
25 DM

The results of estimations of aerodynamic characteristics of the research aircraft Advanced Technologies Testing Aircraft System (ATTAS) from flight test data are reported. The emphasis was on validating and updating the aerodynamic data base predicted by wind tunnel and analytical methods. The estimation of aerodynamic derivatives, carried out by applying a nonlinear maximum likelihood parameter estimation method, is based on the six degree of freedom equations of aircraft motion and a one point aerodynamic model in terms of nondimensional derivatives. From the flight estimated aerodynamic derivatives, an aerodynamic data base is computed in a table look up form suitable for integration in the ground based simulator. The aerodynamic characteristics estimated from flight data are compared with those predicted by wind tunnel and analytical methods.

ESA

N91-32080*# Pennsylvania State Univ., University Park. Gas Dynamics Lab.

AN EXPERIMENTAL STUDY OF FLUCTUATING PRESSURE LOADS BENEATH SWEEPED SHOCK/BOUNDARY-LAYER INTERACTIONS Semiannual Progress Report, 1 Jan. - 30 Jun. 1991

GARY S. SETTLES 30 Jun. 1991 13 p
(Contract NAG1-1070)
(NASA-CR-188919; NAS 1.26:188919) Avail: NTIS HC/MF A03
CSCL 01/1

A database is established on the fluctuating pressure loads

produced on aerodynamic surfaces beneath 3-D shock wave/boundary layer interactions. Such loads constitute a fundamental problem of critical concern to future supersonic and hypersonic flight vehicles. A turbulent boundary layer on a flat plate is subjected to interactions with swept planar shock waves generated by sharp fins. Fin angles from 5 to 25 deg at freestream Mach numbers between 2.5 and 4 produce a variety of interaction strengths from weak to very strong. Miniature Kulite pressure transducers mounted in the flat plate were used to measure interaction-induced wall pressure fluctuations. These data will be correlated with proposed new optical data on the fluctuations of the interaction structure, especially that of the lambda-shock system and its associated high-speed jet impingement.

Author

N91-32081# Federal Aviation Administration, Washington, DC. **ROTORCRAFT MASTER PLAN**

Nov. 1990 54 p
(AD-A239444) Avail: NTIS HC/MF A04 CSCL 01/3

Total rotorcraft operations are expected to double over the next 20 years, with air taxi and business operations leading early growth, and intercity commuter operations expanding in the later years. To support that growth will require adequate infrastructure, advanced aircraft technology, and an expanding supply of trained pilots. The tiltrotor, a proven new vertical lift technology, may play a significant role in establishing intercity commuter operations. Tiltrotors could operate between heliport facilities called vertiports, which are more elaborate and somewhat larger than today's average heliport. This technology has the potential to enhance National Airspace System (NAS) capacity at a fraction of the otherwise necessary investment in new or improved commercial airports. This vision is based on an overall strategy of positive action by private industry, the FAA, other Federal agencies, and state and local governments to encourage the expansion of rotorcraft operations both in current applications and in scheduled passenger and cargo markets in the 200 to 500 nautical mile range. By 2010, rotorcraft could provide as much as 10 pct. of intercity passenger operations capacity in the NAS.

Author

N91-32082# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel. **AERODYNAMICS OF COMBAT AIRCRAFT CONTROLS AND OF GROUND EFFECTS**

G. K. RICHEY, D. H. PECKHAM, ed., and J. LEYNAERT, ed.
(Office National d'Etudes et de Recherches Aeronautiques, Paris, France) 1991 22 p
(AGARD-AR-271) Copyright Avail: NTIS HC/MF A03;
Non-NATO Nationals requests available only from
AGARD/Scientific Publications Executive

The papers presented at the AGARD Fluid Dynamics Panel Symposium on the aerodynamics of combat aircraft controls and of ground effects are summarized and evaluated. The reviewer also provides some general conclusions relative to the effectiveness of the symposium in addressing the problems of the aerodynamics of combat aircraft controls and ground effects in an era when a stretched combat maneuverability envelope is needed to enhance both offensive and defensive combat capability. Recommendations for future experimental and computational fluid dynamics activities are also addressed.

Author

N91-32083 Notre Dame Univ., IN. **COMPRESSIBLE FLOWS WITH VORTICAL DISTURBANCES AROUND A CASCADE OF AIRFOILS** Ph.D. Thesis
JISHENG FANG 1991 222 p

Avail: Univ. Microfilms Order No. DA9122948 CSCL 01/1

Numerical solutions were developed for three dimensional, periodic, vortical flows around a cascade of airfoils. The solutions use the approximation of the rapid distortion theory and thus fully account for the effects of distortion of the vortical disturbances as they propagate through the spatially varying mean flow. The numerical scheme is based on the splitting of the unsteady velocity into a vortical part which is a known function in terms of the upstream flow conditions and the Lagrangian coordinates of the mean flow, and a potential part satisfying a nonconstant coefficient,

inhomogeneous, convective wave equation. A new downstream out-flow boundary condition is proposed to complete the unsteady boundary value problem. By writing the downstream condition in terms of the unsteady pressure, the difficulties associated with the singular behavior of the unsteady vortical velocity are avoided. This condition is relatively simple and suitable for numerical computations. By using a body-fitted coordinate system, the unsteady potential is computed in the frequency domain. The numerical scheme is validated by comparison with flat plate cascade results. In general, the agreement is very good for reduced frequencies ranging from 0 to 5 and Mach numbers from 0 to 0.8. Dissert. Abstr.

N91-32084*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

UNSTRUCTURED-GRID METHODS DEVELOPMENT FOR UNSTEADY AERODYNAMIC AND AEROELASTIC ANALYSES

JOHN T. BATINA, ELIZABETH M. LEE, WILLIAM L. KLEB, and RUSS D. RAUSCH Sep. 1991 12 p Presented at the AGARD Structures and Materials Panel Specialists Meeting, San Diego, CA, 6-11 Oct. 1991

(NASA-TM-104143; NAS 1.15:104143) Avail: NTIS HC/MF A03 CSDL 01/1

The current status of unstructured grid methods development in the Unsteady Aerodynamics Branch at NASA-Langley is described. These methods are being developed for unsteady aerodynamic and aeroelastic analyses. The flow solvers are highlighted which were developed for the solution of the unsteady Euler equations and selected results are given which show various features of the capability. The results demonstrate 2-D and 3-D applications for both steady and unsteady flows. Comparisons are also made with solutions obtained using a structured grid code and with experimental data to determine the accuracy of the unstructured grid methodology. These comparisons show good agreement which thus verifies the accuracy. Author

N91-32085*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN EXPERIMENTAL INVESTIGATION OF A SUPERSONIC VORTICAL FLOW M.S. Thesis - George Washington Univ.

BRIAN S. LEVEY Sep. 1991 142 p (NASA-TM-105102; NAS 1.15:105102) Avail: NTIS HC/MF A07 CSDL 01/1

Although much research has been done on subsonic vortical flow, the current understanding of these flows remains limited. The effect is characterized of adding swirl to a supersonic jet. The motive is to study the enhancement of supersonic mixing in order to provide more efficient fuel injectors for supersonic combustion (scramjet) engines. The vortical flow was created by tangential injection into a swirl chamber ahead of a converging and/or diverging nozzle. The amount of swirl was varied by changing the number of tangential injection holes and with the removal of the end piece, the jet could be run without swirl. Shadowgraphy, conventional schlieren, and focusing schlieren were used to obtain a qualitative understanding of the jet flow structure. It was determined that an increase in swirl produced an increase in the shear layer growth. Pressure and temperature probes were used to obtain more flow data. The probe data compared favorably with the theoretical calculations, except in the viscous core where viscous effects were not considered negligible. These results verified that a supersonic vortical flow was being created with a maximum helix angle of 33 degs. Author

AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A91-53237

ICE, RAIN, FOG, AND FROST PROTECTION

SAE Aerospace Information Report, SAE AIR 1168/4, July 30, 1990, 68 p. refs

(SAE AIR 1168/4) Copyright

The fundamental considerations and equations related to the calculation of ice, water, and fog protection requirements are set forth with methods for protection for aerospace application. Protecting nontransparent surfaces from ice is discussed with specific attention given to thermal ice protection and external factors which affect heat requirements. Other methods of ice protection for nontransparent surfaces include airfoil evaporative antiicing, running-wet antiicing, and electrothermal cyclic deicing. Design considerations are listed to determine the need for ice protection, and examples are given to illustrate typical applications. Windshield fog, frost, and ice protection are then described, and rain removal is mentioned. Hot-air jet blast, windshield wipers, and rain repellents are described and other protective devices are described and presented graphically. C.C.S.

A91-53992

HELICOPTER FLIGHT VIBRATION OF LARGE TRANSPORTATION CONTAINERS - A CASE FOR TEST TAILORING

J. D. ROGERS, D. B. BEIGHTOL, and J. W. DOGGETT (Sandia National Laboratories, Albuquerque, NM) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 515-521. Previously announced in STAR as N90-19215. refs

(Contract DE-AC04-76DP-00789)

Copyright

A testing situation is described in which the test specification was derived from MIL-STD-810D for helicopter flight vibration of some test items. The items were to be inside two very large transportation containers (masses on the order of 2000 to 4000 pounds). Severe testing difficulties were anticipated in achieving the desired levels from the test specification. It was then decided to obtain appropriate field data to modify the test specification. The data were obtained during flights of CH-47D helicopters containing the transportation containers. The vibration levels experienced by the test items were significantly below those specified in the original test plan. Author

A91-54056#

OPERATION JUST CAUSE - A REPORT ON AIRCRAFT DAMAGES AND LOSSES

DONNA EGNER (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 5 p. (AIAA PAPER 91-3140) Copyright

An evaluation is made of aircraft damage and loss data from Operation Just Cause (Panama, December 1989). Shortly after the conflict, the Survivability/Vulnerability Information Analysis Center began to obtain data on aircraft combat damage/repairs. It has been established that 12 C-130s and two C-141s were damaged by small arms fire, as well as 45 helicopters (out of the 167 that participated in the operation). Attention is given to the repair manhours required to repair the damage incurred. O.C.

A91-54295

AIRCRAFT ACCIDENTS - CHANGING THE OUTCOMES

WILLIAM D. WALDOCK (Embry-Riddle Aeronautical University, Prescott, AZ) SAFE Journal, vol. 21, July-Aug. 1991, p. 6-16.

refs

Copyright

The influences of aircraft rescue and firefighting (ARFF) efforts on the fire survivability of commercial aircraft involved in impact survivable accidents are discussed. Three specific accidents are examined in terms of the fire, egress, and response issues involved. The worst and the best responses to controllable situations are reviewed along with the outcomes when ARFF actions are considered.

R.E.P.

A91-55560

AN AIRWORTHINESS CERTIFICATION PROCEDURE FOR THE L-410 UVP-E AIRCRAFT FROM THE STANDPOINT OF AEROELASTICITY [METODIKA PRUKAZU ZPUSOBILOSTI LETOVE LETOUNU L-410 UVP-E Z HLEDISKA AEROELASTICITY]

OTAKAR CERNY, JAROMIR MALECEK, PAVEL MARJANEK, and JAROSLAV RUZICKA Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1991, p. 133-151. In Czech. refs

Copyright

The available experience of the airworthiness certification of the L-410 UVP-E aircraft is summarized with emphasis on aeroelastic effects. In particular, attention is given to the flutter of wings equipped with wingtip tanks, with allowance made for the effects of fuel pumping and sloshing. The relationship between the theoretical and the experimental solution to the problem is examined.

V.L.

A91-55692

THE COMMERCIAL TILTROTOR - CAN IT REALLY HAPPEN?

ROBERT L. NEIR and P. R. THOMPSON (Boeing Commercial Airplane Group, Seattle, WA) Vertiflite (ISSN 0042-4455), vol. 37, Sept.-Oct. 1991, p. 28-33.

Copyright

A study is presented which concludes that commercial tiltrotors can extend the useful life of existing airports and preserve service to congested hubs from smaller communities. Three market sectors among the nine investigated are selected as potential near-term applications, the urban-area-to urban-area market, the 'spine' which connects major city business centers, and the hub feeder. It is noted that a supportive ATC system including procedures acknowledging the tiltrotor's unique operational capabilities is required.

R.E.P.

A91-56225

ICE ACCRETION PREDICTION FOR GAS TURBINE INTAKE SYSTEMS

D. L. MANN, C. G. PUGH, J. R. HOBBS (Rolls-Royce, PLC, Leavesden, England), and S. C. TAN (Cranfield Institute of Technology, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1159-1165. Research sponsored by Rolls-Royce, PLC and Department of Defence of England. refs

Copyright

The paper describes modification made to a general purpose, three-dimensional, particle trajectory-prediction computer code to allow the prediction of water droplet trajectories and ice accretion. The work has concentrated in the area of gas turbine intakes and, in particular, engine-mounted particle separators. The inherently high internal surface area of the intake particle separator leads to a requirement for significant engine power off-takes to provide the necessary antiicing heating. In an effort to minimize the engine performance penalty, a program of research has been undertaken to generate an antiicing system design code. A target to reduce heating requirements by 50 percent from the current generation level has been a stated objective. The paper outlines the theoretical foundations upon which the design code has been based, and goes on to describe three series of validation experiments which have shown the method to be valid. The design system has been configured to maximize flexibility of use.

Author

A91-56468

AIRLINES' VIEW TO TAKE ADVANTAGE OF SATELLITE COMMUNICATION

PETER ISHIKAWA (Japan Airlines Co., Ltd., Tokyo) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 43-50.

Copyright

The use of a satellite datalink is described with respect to ATC systems that can monitor all flights from commercial airline bases or from an ATC system base. Efficient solutions to the present ATC system are discussed which include the integration of flight information regions (FIRs) as well as the introduction of direct routing. In order to collect meteorological data required for flight routes, the establishment of centers is proposed for both Notams and meteorological data. A computer system is proposed which provides navigation data and airport information; these data can be collected by means of the datalink during in-flight communications. The use of facsimile communications is also mentioned to send appropriate meteorological data directly to the cockpit. The integration of FIRs and a satellite-datalink system is concluded to be a more efficient means for ATC and navigation.

C.C.S.

A91-56473

CERTIFICATION STANDARDS FOR COMMERCIAL AIRPLANE TECHNOLOGY AND SYSTEMS OF THE 2010 TIME PERIOD

FRANK F. FICKEISEN (Boeing Commercial Airplane Group, Seattle, WA) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 135-142.

Copyright

Changes in certification requirements and procedures are proposed based on the need for revised safety levels, the availability of new equipment, and the integration of navigation, communication and weather prediction. Requirements for improved safety include safety rates based on current technology and the assumption that the accidents/year rate is expected not to increase. Global positioning systems and digitized communications are among the equipment and systems that can increase safety and expectations. Global communication/navigation is also crucial for revised certification standards, and the limitations of the present regulation FAR 25.1309 are listed. The certification process of the future includes a safety-assessment system, regulations for highly integrated systems, and international regulatory activity.

C.C.S.

N91-31107 Vibro-Meter S.A., Fribourg (Switzerland).

PROCESS FOR DETECTING THE LIKELIHOOD OF ICE FORMATION, ICE WARNING SYSTEM FOR CARRYING OUT THE PROCESS, AND UTILIZATION THEREOF Patent

MARTIN LUSTENBERGER, inventor 7 Mar. 1989 15 p (PATENT-1-250-926; INT-PATENT-CLASS-G08B-108; CTN-91-60144) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MMF \$2.75 CAN

This invention relates to a process and apparatus for detecting the likelihood of natural ice formation on the surface of an aircraft, to a warning system, and to a utilization thereof. The process consist of: positioning a diaphragm having a fundamental resonant frequency and harmonic frequencies on an exposed surface of the aircraft; exciting the diaphragm at one of its resonance frequencies; alternately cooling and heating the diaphragm such that its temperature falls below and rises above the temperature of the exposed surface to alternately create and melt an accretion of ice when the ambient temperature is near or below the freezing point; and measuring any variation in the resonant frequency of the vibration of the diaphragm which occurs during the heating and cooling steps. The fundamental resonance frequency will decrease and the harmonic frequencies increase in the presence

03 AIR TRANSPORTATION AND SAFETY

of an accretion of ice. An alarm is set off when the variation exceeds a predetermined value. In addition, the process measures the ambient temperature, measures the temperature of the diaphragm, and controls the heating and cooling cycle such that the duration of the cycle is dependant on the ambient temperature. CISTI

N91-31108 Leigh Instruments Ltd., Ottawa (Ontario).

BEACON ACTIVATION DEVICE Patent

GEOFFREY DOBBS, inventor 4 Jul. 1989 15 p
(PATENT-1-256-916; INT-PATENT-CLASS-G01S-104;
CTN-91-60168) Copyright Avail: Micromedia Ltd., Technical
Information Centre, 165 Hotel de Ville, Place du Portage, Phase
2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

Crash position indicators (CPIs) are radio beacons which begin automatically to broadcast distress signals upon crashing of the aircraft. They are usually designed such that the beacon is biased to the on-broadcast position. Auxiliary batteries, called shut-off batteries, counterbalance the on bias during normal operation. A number of factors other than crash activation, including human error and shut-off battery failure, can incapacitate the shut-off function and cause the CPI to transmit. This invention provides a CPI that is as reliable as existing systems in its activation, but is also very reliable in holding the beacon in a deactivated mode during flight and ground servicing. It is comprised of a radio transmitter, a battery, and a normally open switch. The device is releasably attached to the aircraft co-acting with an ejector such that in the event of a crash the ejector releases the device from the aircraft. The ejector closes the switch when it operates, thereby turning on the beacon. In a second embodiment the device is equipped with a normally open switch which is deformable. The switch is positioned such that the switch is permanently deformed into a closed position when the ejector operates, thus activating the beacon. CISTI

N91-31109# Materials Research Labs., Ascot Vale (Australia).

TROPICAL TESTS OF A SEAWATER MARKER

R. J. SWINTON and E. GELLERT 1991 20 p
(MRL-TR-90-19) Copyright Avail: NTIS HC/MF A03

A series of tests on the MRL seawater marker were carried out under tropical conditions for the following reasons: (1) to examine the performance of fluorescein in tropical conditions; (2) to compare the MRL marker with commercially available dye marker; and (3) to test a prototype, helicopter-deployed marker device. Results confirmed that fluorescein, in the form used in the commercially available markers, perform poorly in tropical conditions, whilst the MRL marker was vastly superior. The helicopter marker device was deployed from a height of 50 m and was successful in creating a fast-acting, long-duration dye stain over a large area. Author

N91-31110# National Transportation Safety Board, Washington, DC.

ANNUAL REVIEW OF AIRCRAFT ACCIDENT DATA. US AIR CARRIER OPERATIONS, CALENDAR YEAR 1988

18 Apr. 1991 77 p
(PB91-176040; NTSB/ARC-91/01) Avail: NTIS HC/MF A05

The record of aviation accidents is presented involving revenue operations of U.S. Air Carriers including Commuter Air Carriers and On Demand Air Taxis for calendar year 1988. Three major sections are presented according to the federal regulations under which the flight was conducted: 14 CFR 121, 125, 127, Scheduled 14 CFR 135, or Nonscheduled 14 CFR 135. In each section tables are presented to describe the losses and characteristics of 1988 accidents to enable comparison with prior years. Author

N91-31111# Office National d'Etudes et de Recherches
Aerospaciales, Paris (France).

STUDY OF LIGHTNING STRIKES ON AN AIRCRAFT IN FLIGHT. ELECTROMAGNETIC MEASUREMENTS Final Report [ETUDE DE FOUDROIEMENT D'UN AVION EN VOL. MESURES ELECTROMAGNETIQUES]

J. P. MOREAU and L. GAUTIER Jun. 1990 109 p In

FRENCH

(Contract DRET-89-001-19)

(ONERA-RF-25/7234-PY; ETN-91-99939) Avail: NTIS HC/MF A06

Seventeen lightning strikes in flight obtained with the Transall 04 instrumented aircraft were analyzed. Simultaneously recorded electric and magnetic fields relating to discharge current measurements provide basic elements for interpretation of phenomena associated with lightning strikes. High cadence video cameragrams bring an important validation to the proposed physical processes. ESA

N91-31112# Office National d'Etudes et de Recherches Aerospaciales, Paris (France). Direction de la Physique Generale. **STUDY OF LIGHTNING STRIKES ON AN AIRCRAFT IN FLIGHT. ELECTRIC MEASUREMENTS Final Report [ETUDE DU FOUDROIEMENT D'UN AVION EN VOL. MESURES ELECTRIQUES]**

A. DELANNOY, P. BLANCHET, and P. LAROCHE Jun. 1990
82 p In FRENCH

(Contract DRET-89-001-19)

(ONERA-RF-98/7154-PY; ETN-91-99940) Avail: NTIS HC/MF A05

At the time of the Transall aircraft tests campaign of lightning strike study, numerous electric measurements were taken to characterize the atmospheric environment and to determine criteria for lightning initiation. Measurements of the atmospheric electric field, electric conductivity, hydrometeor charges and liquid and solid water presence are analyzed. ESA

N91-31113* National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, CA.

AIRBORNE RESCUE SYSTEM Patent

LEONARD A. HASLIM, inventor (to NASA) 4 Jun. 1991 12 p
Filed 6 Oct. 1989 Supersedes N91-23095 (29 - 15, p 2367)

(NASA-CASE-ARC-11909-1; US-PATENT-5,020,742;

US-PATENT-APPL-SN-418320; US-PATENT-CLASS-244-137.2;

US-PATENT-CLASS-441-83; INT-PATENT-CLASS-B64D-1/08;

INT-PATENT-CLASS-B64D-9/00;

INT-PATENT-CLASS-B64C-1/22;

INT-PATENT-CLASS-B63C-9/01) Avail: US Patent and

Trademark Office CSCL 01/3

The airborne rescue system includes a boom with telescoping members for extending a line and collar to a rescue victim. The boom extends beyond the tip of the helicopter rotor so that the victim may avoid the rotor downwash. The rescue line is played out and reeled in by winch. The line is temporarily retained under the boom. When the boom is extended, the rescue line passes through clips. When the victim dons the collar and the tension in the line reaches a predetermined level, the clips open and release the line from the boom. Then the rescue line can form a straight line between the victim and the winch, and the victim can be lifted to the helicopter. A translator is utilized to push out or pull in the telescoping members. The translator comprises a tape and a rope. Inside the telescoping members the tape is curled around the rope and the tape has a tube-like configuration. The tape and rope are provided from supply spools.

Official Gazette of the U.S. Patent and Trademark Office

N91-32086# EMA, Mansfield, TX.

ANALYSIS OF ROTORWASH EFFECTS IN HELICOPTER MISHAPS Final Report

SAMUEL W. FERGUSON May 1991 59 p Prepared in
cooperation with Systems Control Technology, Inc., Arlington, VA
(Contract DTFA01-87-C-00014)

(DOT/FAA/RD-90/17; SCT-91RR-13) Avail: NTIS HC/MF A04

A selected number of rotorwash related helicopter mishaps were reviewed and analyzed. This analysis attempts to determine threshold levels of rotorwash velocity that result in potential hazards. Due to a lack of detailed mishap information being available, critical threshold values of velocity could not be conclusively identified. However, critical ranges of combined rotorwash and ambient wind velocity were identified for several

types of investigated mishaps. These ranges of peak velocity generally occur between approximately 30 and 40 knots. Recommendations are provided for improvement of the rotorwash mishap reporting system and for the acquisition of experimentally obtained data which will significantly aid any future rotorwash related mishap analysis efforts. Author

N91-32087# National Transportation Safety Board, Washington, DC.

AIRCRAFT ACCIDENT REPORT: AVIANCA, THE AIRLINE OF COLUMBIA, BOEING 707-321B, HK 2016, FUEL EXHAUSTION, COVE NECK, NEW YORK, JANUARY 25, 1990

30 Apr. 1991 292 p

(PB91-910404; NTSB/AAR-91/04) Avail: NTIS HC/MF A13; paper copy also avail. on Standing Order, deposit account required (minimum deposit \$100 US, Canada, and Mexico; all others \$200). Single copies also avail. in paper copy or microfiche CSCL 01/3

The crash of an Avianca Airlines Boeing 707-321B in Cove Neck, Long Island, New York on 25 Jan. 1990 is explained. The safety issues discussed are pilot responsibilities regarding planning, fuel requirements, and flight following during international flights; pilot-to-controller communications; air traffic control flow control procedures; and flightcrew coordination and English language proficiency of foreign crews. Recommendations concerning these issues were addressed to the FAA and the Department Administrativo de Aeronautico Civil (DAAC), Columbia. Author

N91-32088*# Environmental Research Inst. of Michigan, Ann Arbor.

SYNTHETIC APERTURE RADAR IMAGERY OF AIRPORTS AND SURROUNDING AREAS: STUDY OF CLUTTER AT GRAZING ANGLES AND THEIR POLARIMETRIC PROPERTIES Final Report, 31 Aug. 1987 - 30 Dec. 1990

ROBERT G. ONSTOTT, DENISE J. GINERIS, and JAMES T. CLINTHORNE Washington NASA Oct. 1991 200 p (Contract NAS1-18465)

(NASA-CR-4398; NAS 1.26:4398; DOT/FAA/RD-91/14) Avail: NTIS HC/MF A09 CSCL 09/5

The statistical description of ground clutter at an airport and in the surrounding area is addressed. These data are being utilized in a program to detect microbursts. Synthetic aperture radar data were collected at the Denver Stapleton Airport. Mountain terrain data were examined to determine if they may potentially contribute to range ambiguity problems and degrade microburst detection. Results suggest that mountain clutter may not present a special problem source. The examination of clutter at small grazing angles was continued by examining data collected at especially low altitudes. Cultural objects such as buildings produce strong sources of backscatter at angles of about 85 deg, with responses of 30 dB to 60 dB above the background. Otherwise there are a few sources which produce significant scatter. The polarization properties of hydrospheres and clutter were examined with the intent of determining the optimum polarization. This polarization was determined to be dependent upon the ratio of VV and HH polarizations of both rain and ground clutter. Author

N91-32600*# National Severe Storms Lab., Norman, OK.
LIGHTNING THREAT TO AIRCRAFT: DO WE KNOW ALL WE NEED TO KNOW?

VLADISLAV MAZUR In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 8 p Aug. 1991

Avail: NTIS HC/MF A99 CSCL 01/3

The problem of lightning threat to aircraft has two aspects: strike avoidance and aircraft protection. These two issues are addressed under the following topics: (1) lightning strikes, weather conditions, and natural lightning rate; (2) the engineering vs. scientific approach to aircraft protection; and (3) the additional information needed to understand lightning threat to aircraft. K.S.

N91-32601*# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

DESCRIPTION AND INTERPRETATION OF AIRCRAFT LIGHTNING ATTACHMENT ELECTRIC AND MAGNETIC FIELD MEASUREMENTS AND VIDEO OBSERVATION

J. P. MOREAU and S. LARIGALDIE In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 11 p Aug. 1991

Avail: NTIS HC/MF A99 CSCL 01/3

In 1988, ONERA carried out a complete airborne lightning characterization program. Among other features, the program has provided a significant amount of data from analog records of electric and magnetic field sensors to give a description of all stages of the lightning process. The initiation phase has a description of all stages of the lightning process. The initiation phase has been described in the past, so the present objective is to give a description of the other stages of the discharge, based on the observation of analog electromagnetic waveforms and of fast video (200 f/s) image processed pictures. During lightning attachment, the aircraft remains electrically connected to the lightning channel where a large variety of physical processes occur. These physical processes include recoil streamers, return strokes, and even other initiation processes of secondary discharges. Typical records of analog electromagnetic field along with relative luminosity variation of the channel, which shows that there is no extinction of the continuous current throughout the discharge process. A computation of current and potential waveforms using the transmission line formalism is presented and gives satisfactory results for the representation of two of the typical waveforms observed in the recoil streamer processes. Author

N91-32602*# National Severe Storms Lab., Norman, OK.
INTRACLOUD DEVELOPMENT OF LIGHTNING STRIKES TO AIRCRAFT

VLADISLAV MAZUR In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991

(Contract DTFA03-87-A-00021)

Avail: NTIS HC/MF A99 CSCL 01/3

The analysis of airborne electromagnetic records of seven lightning strikes to the FAA CV-580 instrumented airplane during the 1987 field campaign was aimed at revealing and interpreting processes taken place during the intracloud propagation of lightning strikes initiated on or intercepted by the airplane. It is shown that intracloud development of the strike may consist of recoil streamers, dart leader/return stroke sequences, and the secondary initiations of new discharges. These processes, with their high current pulse amplitudes, may present greater threat to aircraft than current pulses during strike initiation. The latter are presently considered by the technical community to be the primary lightning threat to aircraft. Author

N91-32611*# Raychem Ltd., Swindon (England).
THE PERFORMANCE OF CABLE BRAIDS AND TERMINATIONS TO LIGHTNING INDUCED TRANSIENTS

DAVID CROFTS In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991

Avail: NTIS HC/MF A99 CSCL 01/3

The latest specification detailing the test waveforms for indirect lightning transients as applied to aircraft wiring systems specify very high voltages and currents. Although considerable data exists for measuring cable screen leakage using such methods as surface transfer impedance and bulk cable injection, there is little data on the likely core transient level that is likely to be induced from these threats. In particular, the new Waveform 5 at very high current levels (10 kA) is reputed to cause severe cable damage. A range of representative cables were made with various screen termination techniques and screening levels. These were tested first to determine their relative screening performance and then they were subjected to lightning transient testing to all the specified waveforms. Core voltages were measured for each test. Tests were also performed on bundles with fewer wires to determine

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the failure criteria with Waveform 5 and these tests also include flat conductor cables. The test showed that correctly terminated cable bundles performed well in all the tests and would provide a high level of protection to the electronic systems. The use of overbraides, provided the individual screens are well terminated, appears to be unnecessary. Author

N91-32612*# Fokker Space and Systems, Amsterdam (Netherlands).

LIGHTNING PROTECTION OF THE FOKKER 100 CFRP RUDDER

A. J. M. RUITER *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

The construction of the structural parts of the Fokker 100 CFRP rudder is described with respect to the requirements for electrical bonding and lightning protection. Furthermore, the philosophy for the selection of a consumable trailing edge is given. A description of possible alternative designs for trailing edges and their advantages and disadvantages with respect to damage after lightning impact will also be reviewed. An overview of the tests performed on test samples and the rudder construction are presented and discussed. The effectiveness of both the selected structural provisions and trailing edge are described (and proven) by reporting the results of the simulated lightning tests performed. Proof is given that the trailing edge construction and its bonding through the structural parts of the rudder to the main aircraft structure is a solution which results in minor damage to the rudder after lightning impact. Furthermore, it is shown that the selected trailing edge construction is less favored by the structural designers due to the weight penalty. Author

N91-32613*# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.).

PROTECTION OF ELECTRICAL AND ELECTRONIC EQUIPMENT AGAINST LIGHTNING INDIRECT EFFECTS ON THE AIRBUS A340 WING

OLAF SPILLER *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

The provisions applied to the Airbus A340 wing wiring against lightning indirect effects are presented. The construction and installation of the wiring's shielding systems are described, and the analysis and tests performed to determine the effectiveness of the measures taken are discussed. A first evaluation of the results of the theoretical analysis together with the provisional results of tests indicate a sufficient safety margin between required and achieved protection levels. Author

N91-32625*# New Mexico Inst. of Mining and Technology, Socorro. Lab. for Atmospheric Research.

CHARGE CONTROL EXPERIMENTS ON A CH-53E HELICOPTER IN A DUSTY ENVIRONMENT

C. B. MOORE, J. J. JONES, and S. J. HUNYADY *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

Charge control tests were carried out on a ground based, Marine Corps helicopter to determine if control of the electric fields acting on the engine exhaust gases could be used to reduce the electrification of the helicopter when it operated in a dusty atmosphere. The test aircraft was flown to a dusty, unpaved area and was then isolated electrically from the earth. When the helicopter engines were operated at ground idle with the rotor locked, the isolated aircraft charged positively, as had been observed previously. However, when the rotor brake was released and the turning rotor created a downdraft that raised dust clouds, the aircraft always became charged more positively, to potentials ranging from +30 to +45 kV. The dust clouds raised by the rotor downwash invariably carried negative space charges with

concentrations of up to -100 nC/cu m and caused surface electric fields with strengths of up to 10 kV/m immediately down wind of the aircraft. The natural charging of the helicopter operating in these dust clouds was successfully opposed by control of the electric fields acting on the hot, electrically conductive exhaust gases. The control was achieved by placing electrostatic shield around the exhausts. Author

N91-32626*# Naval Air Test Center, Patuxent River, MD. Electromagnetic Pulse Section.

RESULTS OF THE RECENT PRECIPITATION STATIC FLIGHT TEST PROGRAM ON THE NAVY P-3B ANTISUBMARINE AIRCRAFT

MIKE WHITAKER *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 7 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

Severe precipitation static problems affecting the communication equipment onboard the P-3B aircraft were recently studied. The study was conducted after precipitation static created potential safety-of-flight problems on Naval Reserve aircraft. A specially designed flight test program was conducted in order to measure, record, analyze, and characterize potential precipitation static problem areas. The test program successfully characterized the precipitation static interference problems while the P-3B was flown in moderate to extreme precipitation conditions. Data up to 400 MHz were collected on the effects of engine charging, precipitation static, and extreme cross fields. These data were collected using a computer controlled acquisition system consisting of a signal generator, RF spectrum and audio analyzers, data recorders, and instrumented static dischargers. The test program is outlined and the computer controlled data acquisition system is described in detail which was used during flight and ground testing. The correlation of test results is also discussed which were recorded during the flight test program and those measured during ground testing. Author

N91-32631*# Centre d'Essais Aeronautique Toulouse (France). INFLUENCE OF CONFIGURATION EFFECTS ON MULTIPLE BURST SIMULATION TESTING

J. L. EMANUELY and M. CANTALOUBE *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

During the initial phase of a lightning strike attachment on an aircraft, fast current pulses (rise time approximately 100 ns, $I_{sub\ max}$ approximately few kA) were measured, which can create equipment upsets or disturbances. This threat, made of repetitive pulses and usually called 'multiple bursts', can be reproduced at the equipment interfaces assuming that the transfer function of the structure was determined. The normalized waveform H (10 kA - 100 ns rise time) is the reference for one of these pulses. The importance of the coaxial return path termination for the injection of the wave H is emphasized. According to the constitutive materials of the test bed, and the adaptation of the line, the natural oscillations of the structure and the internal coupling mechanisms can be modified. As a conclusion, various test configurations in relation with the nature of the test bed and the characteristics of the generator are detailed, for a more accurate ground simulation of the attachment phase. Author

N91-32637*# Office National d'Etudes et de Recherches Aeronautiques, Paris (France).

FD-TD CALCULATION WITH COMPOSITE MATERIALS. APPLICATION TO C160 AIRCRAFT MEASUREMENTS

J. C. ALLIOT, J. GRANDO, F. ISSAC, and X. FERRIERES (SLX Informatique, Courbevoie, France) *In* NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 01/3

In a frequency domain in which a material thickness is smaller than the skin depth, a formalism based on the sheet impedance

concept was developed and introduced in the FD-TD (finite difference-time domain) code ALICE. The predictive capabilities of the 3D code was evaluated by comparison to analytical and experimental data. The following subject areas are covered: low frequency electromagnetic penetration of loaded apertures; FD-TD modeling; and in-flight experiment modeling. Author

N91-32641*# Atlantic Research Corp., Arlington, VA. Professional Services Group.

AN ASSESSMENT OF TAILORING OF LIGHTNING PROTECTION DESIGN REQUIREMENTS FOR A COMPOSITE WING STRUCTURE ON A METALLIC AIRCRAFT

T. L. HARWOOD /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 12 p Aug. 1991
 Avail: NTIS HC/MF A99 CSCL 01/3

The Navy A-6E aircraft is presently being modified with a new wing which uses graphite/epoxy structures and substructures around a titanium load-bearing structure. The ability of composites to conduct electricity is less than that of aluminum. This is cause for concern when the wing may be required to conduct large lightning currents. The manufacturer attempted to solve lightning protection issues by performing a risk assessment based on a statistical approach which allows relaxation of the wing lightning protection design levels over certain locations of the composite wing. A sensitivity study is presented designed to define the total risk of relaxation of the design levels. Author

N91-32642*# United Kingdom Atomic Energy Authority, Abingdon (England).

LIGHTNING PROTECTION DESIGN AND TESTING OF AN ALL COMPOSITE WET WING FOR THE EGRETT

B. J. C. BURROWS, S. J. HAIGH, C. CHESSUM, and V. P. DUNKLEY /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991 Sponsored in part by Grob Aircraft Co., Mindelheim, Fed. Republic of Germany
 Avail: NTIS HC/MF A99 CSCL 01/3

The Egrett aircraft has an all composite wing comprising CFC(carbon fiber composite)/Nomex sandwich skins, full length CFC main spar caps, and GFRP (glass fiber reinforced plastics) main and auxiliary spar webs. It also has short inboard CFC auxiliary spar caps. It has fine aluminum wires woven into the surface for protection. It has an integral fuel tank using the CFC/Nomex skins as the upper and lower tank walls, and lies between the forward auxiliary spar and the forward of the two main spar webs. The fuel tank is not bagged, i.e., it is in effect a wet wing tank. It has conventional capacitive type fuel gauging. The aircraft was cleared to IFR standards and so required full lightning protection and demonstration that it would survive the lightning environment. The lightning protection was designed for the wing (and also for the remainder of the aircraft). An inner wing test samples (which included a part of the fuel tank) were tested as part of the proving program. The protection design and the testing process are described. The intrinsic structural features are indicated that improve lightning protection design and which therefore minimize the weight and cost of any added lightning protection components. Author

N91-32648*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

FD-TD NUMERICAL SIMULATION OF AN ENTIRE LIGHTNING STRIKE ON THE C160 AIRCRAFT

J. C. ALLIOT, J. GRANDO, J. D. MULLER, and X. FERRIERES (SLX Informatique, Courbevoie, France) /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 11 p Aug. 1991 Previously announced in IAA as A91-45619
 Avail: NTIS HC/MF A99 CSCL 01/3

Experimental transient electromagnetic field measurements were performed on a Transall C160 aircraft during in-flight lightning strikes. The data allow a test of the predictive capabilities of a three dimensional time domain finite difference code (ALICE)

developed at ONERA in order to investigate lightning-aircraft interactions. Using a transfer function technique in the 3D code, it is shown that a bi-leader attached to an aircraft can be simulated by a linear model, and so the electromagnetic fields can be calculated anywhere on the vehicle. Comparison of experimental and numerical results were made for several lightning strikes. Skin current density and electromagnetic field distributions are discussed in detail. Author

N91-32650*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

APPLICATION OF SURFACE ELECTRICAL DISCHARGES TO THE STUDY OF LIGHTNING STRIKES ON AIRCRAFT

J. L. BOULAY and S. LARIGALDIE /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991 Previously announced in IAA as A91-45612
 Avail: NTIS HC/MF A99 CSCL 01/3

Considered here is the characterization of surface discharges which provide a facility complementary to that of artificially triggered lightning. General characteristics of a simplified surface discharge, including current waveforms and the constitution of a surface discharge are outlined, and the application of this approach to the study of aircraft lightning strikes is considered. Representations of leader-streamer and return-stroke phases are discussed, and the application to the two-dimensional discharge phase is covered. It is noted that the fact that the initiation times of surface discharges could be controlled, and the path followed by the discharge channels could be predetermined, indicates that it is possible to produce a highly dedicated high performance instrumentation system. Author

N91-32651*# SRI International Corp., Menlo Park, CA.
SCALE-MODEL CHARGE-TRANSFER TECHNIQUE FOR MEASURING ENHANCEMENT FACTORS

J. KOSITSKY and J. E. NANEVICZ /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991 (Contract F04701-90-C-0023)
 Avail: NTIS HC/MF A99 CSCL 01/3

Determination of aircraft electric field enhancement factors is crucial when using airborne field mill (ABFM) systems to accurately measure electric fields aloft. SRI used the scale model charge transfer technique to determine enhancement factors of several canonical shapes and a scale model Learjet 36A. The measured values for the canonical shapes agreed with known analytic solutions within about 6 percent. The laboratory determined enhancement factors for the aircraft were compared with those derived from in-flight data gathered by a Learjet 36A outfitted with eight field mills. The values agreed to within experimental error (approx. 15 percent). Author

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AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A91-53154

TACAMO ANTENNA ANALYSIS FOR THE NEW HIGH POWER TRANSMIT SET (HPTS)

M. B. EL-ARINI, SAMEH A. MITRY, and RICHARD LEE (Mitre Corp., McLean, VA) IN: MILCOM '90 - IEEE Military Communications Conference, Monterey, CA, Sept. 30-Oct. 3, 1990, Conference Record. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 1071-1079. refs
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The computer modeling of a dual-trailing wire antenna (DTWA) on a TACAMO aircraft is described. This model is used to study

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the impact of the shape of the DTWA on the impedance of the antenna and the impact of this impedance variation on the high-power transmit set (HPTS) antenna coupler capabilities (e.g., the antenna impedance matching range and the power amplifier loading). Parameters that affect the shape of the DTWA, such as phase of the flight, weight, altitude, velocity, and orbit radius, are utilized by the model. Results of impedance matching range and power amplifier loading comparisons are presented. I.E.

A91-54083#

OPERATIONAL FLIGHT TEST OF E-9A AIRCRAFT SYSTEMS

S. P. HERRLINGER (USAF, Tactical Air Warfare Center, Tyndall AFB, FL) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 17 p. refs
(AIAA PAPER 91-3172)

The operational effectiveness of the E-9A airborne platform/telemetry relay is evaluated in a flight test in terms of general communications capability and four subsystems. The subsystems include the telemetry relay, the UHF voice relay, radar sea surveillance, and the Gulf Range drone-control-relay data link. The telemetry system is tested during the standard weapons-system evaluation program (WSEP), advanced medium-range air-to-air missile missions, and dedicated multipath/shielding telemetry flights. Relay capabilities for UHF voice communications and the acquisition of boat-position data are examined for all possible mission types. The E-9A capability for supporting drone-control relay operations is evaluated for drone-control and WSEP missions. Some isolated operational problems are reported, but the subsystems of the E-9A are found to facilitate missile firings and sea surveillance. C.C.S.

A91-54664

PROGRAMMABLE DIGITAL COMMUNICATIONS RECEIVER ARCHITECTURE FOR HIGH DATA RATE AVIONICS AND GROUND APPLICATIONS

JAMES LUECKE and MICHAEL JORDAN (Interstate Electronics Corp., Anaheim, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 552-556. refs
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The architecture for an advanced, modular, all-digital programmable receiver capable of processing bandwidth-efficient digital modulation schemes at data rates well in excess of 100 Mb/s is described. The receiver is designed around a digital, parallel processing architecture to support high throughput rates while being adaptable to both continuous and burst communication systems. Based on the combined use of GaAs and CMOS technologies, a digital architecture that provides significant processing flexibility is presented. The programming of all critical receiver functions and attributes is supported through this architecture. The general concept is based on a set of high-speed programmable and reconfigurable building blocks that provide the user complete control of the demodulation, tracking, and data-processing functions. I.E.

A91-54665

APPLICATION-BASED REQUIREMENTS FOR DATA LINKED WINDS ALOFT

GARY G. NELSON (Mitre Corp., McLean, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 557-561. refs
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The winds aloft are important for choosing flight trajectories and predicting arrivals or conflicts in airspace. Frequent samples of the winds aloft taken by aircraft can contribute to better weather forecasting, and they can also be used directly in flight applications. The applicability of wind measurements by in-trail aircraft for trajectory arrival forecasting was investigated. The results are used to recommend wind sampling parameters by aircraft and to assess

the impact of wind report downlinks on Mode S data link loadings. It is pointed out that reports of winds and temperatures aloft are already operationally implemented and can be contributed by multiple data links to multiple air and ground users in the future. Even if only Mode S data link is relied upon, the downlink utilization should be tolerable. While constant report rates up to 10 minutes per aircraft may suffice as forecast inputs, real-time en route and terminal ATC applications require decreasing per-aircraft sampling periods with airspace utilization. It is concluded that this and data link constraints argue for the contract polling mode, putting responsibility on the applications themselves for defining sampling parameters of each aircraft. I.E.

A91-54666

USER BENEFITS OF DATA LINK IN THE AERA ENVIRONMENT

NORA LAWSON (Mitre Corp., McLean, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 562-569. refs
Copyright

One of the key elements of the National Airspace System Plan is the advanced automation system (AAS), which provides new hardware and software to be used in ATC (air traffic control). An enhancement current to the AAS will be the automation capabilities collectively known as automated en route ATC (AERA). AERA is being designed with several goals in mind: to enhance safety, increase user benefits, increase controller productivity, and increase system capacity. To meet these goals, many AERA capabilities are being designed, one of which is the increased use of data link. AERA data link capabilities are described, showing how AERA's use of data link will provide user capabilities to accommodate requests better than has been possible in the past, while reducing the amount of verbal communication required with the aircrew and reducing communication errors. I.E.

A91-54667

OPERATIONAL EVALUATION OF DATA LINK AIR TRAFFIC CONTROL SERVICES

NICHOLAS J. TALOTTA (FAA Technical Center, Atlantic City, NJ) and CLARK A. SHINGLEDECKER (NTI, Inc., Dayton, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 570-575. refs
Copyright

The FAA has begun the development of a digital data link system intended to augment congested voice radio channels currently used for communication between ground-based air traffic controllers and airborne flight personnel. As a major part of this effort, the FAA technical center is pursuing a research program to design and evaluate controller and pilot procedures, displays, and inputs which will effectively support the delivery of weather and ATC services to data-link-equipped aircraft. A continuing series of manned simulation studies that are being conducted to evaluate and refine candidate service designs and to determine their utility in the operational ATC environment are described. Detailed results are presented from an operational evaluation study in which four data link en route ATC services and functions were tested in a full-scale simulation with both FAA controllers and professional pilots participating. Current research efforts aimed at examining expanded en route services and at developing terminal area applications of data link are discussed. I.E.

A91-54668

GLOBAL POSITIONING SYSTEM INTEGRITY CHANNEL - A SYSTEM DESIGN ANALYSIS

BARRY A. STEIN and WAI L. TSANG (Science Applications International Corp., McLean, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 576-581. refs
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A system design analysis of the GPS integrity channel (GIC), which distributes integrity information to civil aviators equipped with GIC avionics, is presented. The GIC system encompasses ground stations monitoring the integrity of GPS signals-in-space. The information is centrally processed by a master upload station (MUS) where GPS integrity information is generated. A GIC data link is established to carry the GIC information. Reception and processing of the integrity message are performed by the GIC avionics. A proposed GIC system design is analyzed. The study covers a point-to-point communication link starting with the data collection process at the monitoring stations and ending with the integrity message extraction by the GIC avionics. The design uses a star network topology for connecting the ground monitor stations to the MUS with triple redundant transmissions to ensure reliability. Timing analysis has been performed to ensure the feasibility of the design, and it was demonstrated that the proposed system could meet the imposed time-to-alarm limit for different flight phases. I.E.

A91-54718**COMMUNICATION LINKS FOR RPV SYSTEMS USING RELAYS**

J. R. SHARMAN and J. E. BARRETT (STC Radio and Microwave, Paignton, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 23.1-23.10. Research supported by Ministry of Defence of England.

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The requirement for a wide bandwidth video link in RPV systems where transmissions at high frequencies is only possible over line of sight paths is presented. Candidates for the relay vehicle are described with the parameters that define the choice of the relay electronics package and the antennas required to provide the required communications coverage. The benefits of various position fixing schemes are compared and the need to fix the position of the mission and relay vehicles is discussed. R.E.P.

A91-54719**BENEFITS OF SPREAD SPECTRUM TECHNIQUE FOR THE RPV COMMUNICATION AND GUIDANCE SYSTEMS**

MILAN KOVACEVIC (Institute for Microwave Technique and Electronics, Belgrade, Yugoslavia) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 24.1-24.12. refs

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The direct spread spectrum technique including antijamming and ranging is discussed. It is shown that the direct sequence-spread spectrum system technique can offer good results both in range and angle measurements of the RPV position.

R.E.P.

A91-54722**AIR NAVIGATION SYSTEMS. IV - HYPERBOLIC AIRBORNE RADIO NAVIGATION AIDS: A NAVIGATOR'S VIEW OF THEIR HISTORY AND DEVELOPMENT**

W. F. BLANCHARD (Royal Institute of Navigation, London, England) Journal of Navigation (ISSN 0373-4633), vol. 44, Sept. 1991, p. 285-315. refs

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A historical overview is presented of hyperbolic airborne radio navigation aids, defined as a system that uses comparatively widely-spaced sources of radio energy acting together to produce navigational cover over a large area in terms of hyperbolic functions. Early patents and proposed systems are discussed along with evolutionary patterns that illustrate the development of more recent applications. Attention is given to various systems developed by a number of countries including Loran, Decca, Consol/Sonne, Gee, Chaika, and Omega. R.E.P.

A91-54723**SAFE VERTICAL SEPARATION OF AIRCRAFT**

STANLEY RATCLIFFE Journal of Navigation (ISSN 0373-4633),

vol. 44, Sept. 1991, p. 386-391. refs

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A review is presented of the instruments and procedures that have been developed to provide the safe vertical separation of aircraft in commercial transport operations. Consideration is given to various tests on flight-level accuracy and the problems associated with recurring errors in height-keeping. Attention is given to the airline radio and inertial avionics systems, and the advent of satellite navigation systems that offer an alternative measure of vertical position, geocentric height. R.E.P.

A91-55415**RADIO AIR NAVIGATION (HANDBOOK) [AVIATIONNAIA RADIONAVIGATSIYA /SPRAVOCHNIK/]**

ANDREI A. SOSNOVSKII, IZIDOR A. KHAIMOVICH, EMIL' A. LUTIN, and IGOR' B. MAKSIMOV Moscow, Izdatel'stvo Transport, 1990, 264 p. In Russian. refs

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The handbook contains data on the organization, operation, and equipment of radio navigation systems. In particular, attention is given to the structure and composition of navigation systems for the landing of airplanes and helicopters; types of navigation systems; signal types; and standards for the parameters, signals, and radio equipment of short-range and long-range navigation systems. Data are also presented on Doppler velocimeters and meteorological radars. V.L.

A91-56466**RADIO TECHNICAL COMMISSION FOR AERONAUTICS, ANNUAL ASSEMBLY AND TECHNICAL SYMPOSIUM, WASHINGTON, DC, DEC. 3-5, 1990, PROCEEDINGS**

GEORGE STRASCHNOV, ED. (Radio Technical Commission for Aeronautics, Washington, DC) Washington, DC, Radio Technical Commission for Aeronautics, 1990, 184 p. For individual items see A91-56467 to A91-56475.

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The present conference of the Radio Technical Commission for Aeronautics encompasses requirements for a global integrated-system approach for 21st century air transportation including total-system functional requirements, operations requirements, and opportunities in air-traffic-management communications and the airborne segment. Specific issues addressed in the symposium include the functional requirements of international air-navigation systems, aviation-related radio-spectrum policy, the airline industry view of satellite communications, digital CNS, and the role of satellites in airspace management. Also addressed are airport-communications needs, voice and data communications integration for air-transport communications, certification standards for commercial airplane technology, advances in airborne computer technology, and technical and industrial considerations for systems integration. C.C.S.

A91-56467**INTERNATIONAL AIR NAVIGATION SYSTEM FUNCTIONAL REQUIREMENTS**

H. B. O'KEEFE (Civil Aviation Authority, Canberra, Australia) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 27-34.

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The development of the requirements for the Future Air Navigation System (FANS) is presented which emphasizes the utility of a totally integrated air-traffic system. The limitations of present systems are identified as propagation problems, implementation constraints, and limited voice and digital communications. The FANS communication, navigation, and surveillance (CNS) concept includes voice and data communication by direct aircraft-satellite link, the incorporation of GPS and other global-navigation satellite systems presently under development, and a concept called automatic dependent surveillance. The transition to the FANS system is described in terms of its benefits

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and the projected time scale, and implementation on a global scale is identified as a crucial objective. The FANS concept can overcome present limitations with CNS and air-traffic systems that integrate technologies and provide global implementation. C.C.S.

A91-56469

DIGITAL CNS - AVIATION'S THREE-LEGGED STOOL

WILLIAM H. STINE, II (National Business Aircraft Association, Inc., Washington, DC) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 55-60.

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A general approach to communications, navigation and surveillance (CNS) is developed in which all three elements of the system are considered and can form the basis of air traffic management (ATM). Digital data communications are proposed for all phases of ATM, and forms of transmission and system types are discussed. Several problems are mentioned related to navigation systems and satellites such as the GPS including black-box limitations, coordinations with airports, and the certification of avionics modules. Surveillance considerations are then discussed with attention given to its near-term potential because it can eliminate the need for other systems to locate and identify aircraft. The essential operation of the CNS system is outlined, and the use of a controller is not considered in the CNS system. C.C.S.

A91-56470

THE AERONAUTICAL TELECOMMUNICATIONS NETWORK OF THE FUTURE

FORREST W. COLLIVER (Mitre Corp., Civil Systems Div., Bedford, MA) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 87-108. refs

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Global data-networking infrastructure for air-traffic management (ATM) automation is described which can serve fixed and mobile users and relies on advanced airborne computers as well as ground-based units. The network is referred to as an internet which comprises several heterogeneous subnetworks with gateways or routers. The requirements of internetworking are listed and include autonomous internetwork management, dynamic adaptation to topology changes, global routing, and connectivity via heterogeneous subnetworks. The Aeronautical Telecommunication Network (ATN), a protocol architecture for ATM and other uses, is presented. The domain and connectivity related to its use are given, and internetworking in the ATN environment is discussed. Specifics of the ATN concept are presented including the internet routing procedures, constituent subnetworks, internet addresses, and the internet domain structure. C.C.S.

A91-56471

SATELLITES AND THEIR ROLE IN FUTURE AIRSPACE MANAGEMENT

GEORGE TELLMANN and WILLIAM B. GARNER (American Mobile Satellite Corp., Washington, DC) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 109-117.

Copyright

The use of aeronautical mobile satellite service (AMSS) is discussed in terms of the Future Air Navigation Systems (FANS) study for communications, navigation, and surveillance satellites. The availability of suitable communications satellites is identified as an important objective, and systems such as Inmarsat and others under construction are reviewed. AMSS capabilities are projected to include satellites with wide coverage that can support multiple radio-channel types. Modification of the satellites is accomplished on earth, and multiple interconnecting networks permit global service with no single point of failure. The applications of the AMSS are primarily for international oceanic areas where

communication is poor, and uses include voice and data communications for passengers on the aircraft. The AMSS is concluded to satisfy the minimum standards and recommended practices for global air-traffic management communication. C.C.S.

A91-56472

VOICE AND DATA COMMUNICATIONS INTEGRATION FOR AIR TRANSPORT COMMUNICATIONS

JAMES R. KING (Rockwell International Corp., Collins Air Transport Div., Cedar Rapids, IA) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 127-133.

Copyright

The current status of analog and digital communications is reviewed with respect to the evolution of numerous worldwide telecommunications networks for air transport. Voice communications from the cockpit are found to be basically unchanged since their inception: one frequency is shared by a controller and all aircraft in communication. The limitations of aircraft/controller communications are enumerated, and the use of VHF ACARS communication is proposed for alleviating the congestion on existing channel frequencies. Single-channel satellite voice communications are described for use in long-range communications, and Mode-S data-link transponders can be employed as an interrogator ground network. Wide integration of the existing uncoordinated air-transport communications networks is identified as a primary objective of future development. C.C.S.

A91-56823

FLIGHT EVALUATION OF CURVED INSTRUMENT APPROACHES USING PRECISION GUIDANCE PROVIDED BY A MICROWAVE LANDING SYSTEM

JOHN B. CROLL (National Research Council of Canada, Flight Research Laboratory, Ottawa) Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 37, June 1991, p. 66-71. refs

Flight testing of curved, segmented approaches using a Microwave Landing System (MLS) was conducted on a Twin Otter aircraft belonging to the Canadian National Research Council's Institute for Aerospace Research (IAR). Algorithms were written to define several different approach configurations and to provide precision guidance to both straight and curved segments. These algorithms were developed and validated in flight during the software development phase of the project. A pilot evaluation phase was subsequently flown to assess the tracking accuracies and pilot workload associated with flying these approaches. Standard aircraft electromechanical flight instruments were modified slightly to assist the pilots. All approaches were flown successfully to Category I limits using instruments only, despite some problems in the performance of the lateral flight director. Approach track deviations and pilot workload were found to increase as a direct function of the track angle changes on the curved segments, though influenced by the limitations of the lateral flight director. Several observations were made with respect to complex approach design and pilot-situational awareness requirements. Author

A91-56989

TEST RESULTS OF GPS INTEGRATION WITH CARRIER AIRCRAFT INERTIAL NAVIGATION SYSTEM (CAINS)

KEVIN L. GRIMES (U.S. Navy, Naval Avionics Center, Indianapolis, IN) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 15-21. refs

Results from CAINS-IA/II flight testing with closed-loop GPS aiding, and CAINS-IA/II testing of at sea alignments with shipborne Dual Mini-Inertial Navigation System damped with GPS data are discussed. These results show the benefits of GPS aiding to CAINS for navigation accuracy and during inflight alignment. Attention is given to a description of the GPS/CAINS system architecture, configuration, integration approach, and interfaces. R.E.P.

A91-56990

ON GPS VELOCITY

MARVIN MAY, KHIE NGUYEN, and BEREKET TANJU (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 23-32. refs

Some of the fundamental aspects which relate the actual measurements a GPS receiver provides to the GPS equipment's indicated velocity outputs are examined. The effects of delta range averaging interval, geometry, extrapolation, tracking loop errors, and solution methods are discussed. Tradeoffs connected with using position, position and velocity, and/or raw pseudorange/delta range outputs for velocity sensitive applications are determined.

R.E.P.

A91-56993

A CURVED APPROACH WITH ILS/LORAN-C

RICHARD H. MCFARLAND (Ohio University, Athens) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 153-156. refs

The paper suggests the joint use of Loran-C and ILS to provide a capability to execute curved approaches to landing. The concept of curved approaches presented, while somewhat different from those of RTCA/DO-198, involves use of a blend of two systems for executing a curved flight track along with utilization of a contemporary HSI cockpit presentation for the pilot. A set of assumptions is given, and a comparison of positional accuracies available from the two systems results in their being deemed adequate for a final approach fix of 5 miles near where the transition from a curve to a straight line would take place. A combination of the signals from the two systems along with computational and display capabilities on board the aircraft can provide for other than the common, straight-in approach to landing.

Author

A91-56994

OPTIMIZATION OF THE HIGH ANGLE OF ATTACK FLUSH AIR DATA SENSING (HI-FADS) SYSTEM ALGORITHM EXECUTED IN REAL-TIME ON MULTI-PROCESSOR TRANSPUTER NETWORKS

DAVID K. TANIGUCHI (McDonnell Aircraft Co., Saint Louis, MO) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 157-164. refs

Evaluation of the processing requirements for the HI-FADS algorithm as related to potential real-time, airborne applications is described. Concurrent algorithm execution was evaluated on multiprocessor systems of various configurations with networks of transputers. With regard to system design constraints and algorithm structure, computing throughput and latency were optimized for each network and then related to the performance characteristics of single transputer execution.

R.E.P.

A91-57000

THE H-764 SMALL COMMON INS (SCINS) - A NEW RLG SYSTEM FOR THE NEXT GENERATION AIRCRAFT AND COMBAT VEHICLES

MICHAEL J. HADFIELD and ALAN J. HASSELBRING (Honeywell, Inc., Military Avionics Div., Saint Petersburg, FL) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 209-218.

A review is presented of the design, development and testing of the H-764 SCINS incorporating Ring Laser Gyro (RLG) INSs to meet the requirements of various applications ranging from fixed wing to rotary wing aircraft. Attention is given to the system hardware, electrical power, power requirement reductions, and packaging and thermal control. Consideration is given to the general system architecture, hardware and software functions, angular random walk tests, and laboratory and flight tests.

R.E.P.

N91-31114# Flight Digital Co., Las Cruces, NM.

DEVELOPMENT OF A GEOGRAPHIC NAVIGATIONAL DISPLAY DEVICE FOR GENERAL AVIATION AIRCRAFT Final Report

M. P. SQUIRES Feb. 1991 126 p Sponsored by New Mexico Research and Development Inst., Albuquerque (PB91-170282; NMRDI-2-76-5622) Avail: NTIS HC/MF A07 CSDL 17/7

The goal was to produce a pilot friendly, relatively inexpensive navigation display unit for general aviation aircraft which would diminish the navigational workload by quickly providing a vast amount of data while demanding minimal attention from the pilot. The project began in March 1988, ending in December 1990, with the NavScreen Model FD-100 accepted by the FAA for installation in certified aircraft. The NavScreen is an exciting, new, low cost way of displaying navigation information, using LORAN position data to show pilots at a glance, on a moving map display, where they are, where they are going, and where they have been with respect to all airports 100 nm from their present location. Over 11,000 U.S. airport diagrams are contained on one easily updated 3-1/2 inch diskette which slides in the front of the unit. The NavScreen fits a standard 4 x 6 inch avionics slot in the instrument panel.

GRA

N91-31116 Grumman Aerospace Corp., Bethpage, NY.

PASSIVE RANGING OF AN AIRBORNE EMITTER BY A SINGLE NON-MANEUVERING OR STATIONARY SENSOR Patent

MARTIN GOLINSKY, inventor 16 May 1989 19 p (PATENT-1-254-292; INT-PATENT-CLASS-G01S-302; INT-PATENT-CLASS-G01S-352; CTN-91-60173) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

The present invention relates to a passive range sensor which is capable of measuring the range of a moving target, such as an aircraft from a stationary platform, an air traffic control tower, or from another aircraft moving along a linear trajectory at a constant velocity. The system uses a succession of bearing and frequency measurements obtained on an appropriate sensor at discrete periods of time from a radiant signal emitted by the target vehicle. The emitted radiation may be continuous or pulsed. The sensor collects frequency and bearing information on the emitter at discrete intervals. As a result of the combined movement of the target and sensor there is produced a geometric pattern of rays of received radiation which can be used to derive the desired range information. Its velocity and direction of travel may also be determined. The system may be used by ships employing sonic sensors and by satellites employing optical sensors. For the system to be accurate the target must not be maneuvering, and the test vehicle must be located sufficiently far from the target that they can be assumed to be in the same horizontal plane.

CISTI

N91-31119# National Aerospace Lab., Amsterdam (Netherlands). Flight Informatics Div.

BAYESIAN MULTI-SENSOR TRACKING FOR ADVANCED AIR-TRAFFIC CONTROL SYSTEMS

H. A. P. BLOM, R. A. HOGENDOORN, and F. J. VANSCHAIK 8 May 1988 12 p Presented at the Guidance and Control Panel AGARDograph 301 on Computation, Prediction and Control of Aircraft Trajectories Previously announced as N91-11003 Sponsored by Dutch Organization of Civil Aviation (NLR-MP-88056-U; ETN-91-99656; AD-B153479L) Avail: NTIS HC/MF A03

An overview of a Bayesian tracking system for a multisensor environment is given. The main modules perform track initiation, track continuation, and systematic error estimation, respectively. The track continuation module plays the most important role for air traffic control. It consists of a combination of those approximate Bayesian methods that proved to be the most efficient for the main problems of track continuation: extended Kalman filtering for nonlinear dynamics, probabilistic data association for unassociated measurements, and interacting multiple model filtering for sudden

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maneuvers. Comparisons of this new tracking system with alpha-beta, Kalman based, and state of the art tracking systems show its superiority for application to air traffic control surveillance. The advantages of this system are given. ESA

N91-31120* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRPLANE TAKEOFF AND LANDING PERFORMANCE MONITORING SYSTEM Patent

DAVID B. MIDDLETON, inventor (to NASA), RAGHAVACHARI SRIVATSAN, inventor (to NASA), and LEE H. PERSON, JR., inventor (to NASA) 10 Sep. 1991 28 p Filed 6 Aug. 1987 Supersedes N88-24621 (26 - 18, p 2462) Continuation-in-part of US-Patent-Appl-SN-082766

(NASA-CASE-LAR-13854-1-CU; US-PATENT-5,047,9421-CU; US-PATENT-APPL-SN-192562; US-PATENT-APPL-SN-082766; US-PATENT-CLASS-364-427; US-PATENT-CLASS-364-428; US-PATENT-CLASS-73-178T; INT-PATENT-CLASS-G06F-15/50) Avail: US Patent and Trademark Office CSCL 17/7

The invention is a real-time takeoff and landing performance monitoring system for an aircraft which provides a pilot with graphic and metric information to assist in decisions related to achieving rotation speed within the safe zone of a runway, or stopping the aircraft on the runway after landing or takeoff abort. By comparing the present performance of the aircraft with a predicted nominal performance based upon given conditions, performance deficiencies are detected by the system. The system provides a head-down display and a head-up display. The head-up display is projected onto a partially reflective transparent surface through which the pilot views the runway. Hence, the system supplies the pilot with critical status information while allowing the pilot to continue to view the runway.

Official Gazette of the U.S. Patent and Trademark Office

N91-32092# Federal Aviation Administration, Atlantic City, NJ. **RESULTS OF MLS/ILS COMPARISON FLIGHT TEST AT THE YUMA MCAS, ARIZONA Technical Report, Jun. 1990**

CLIFFORD W. MACKIN Jul. 1991 21 p (Contract NASA ORDER T-0604L) (DOT/FAA/CT-TN91/10) Avail: NTIS HC/MF A03

A series of flight tests were performed by the FAA Technical Center at the Marine Corps Air Station (MCAS) to obtain Microwave Landing System (MLS) performance data and to compare the performance of a commissioned Category 1 Instrument Landing System (ILS) with the performance of a prototype MLS. The Technical Center's test bed MLS was transported to and collocated with the commissioned Category 1 ILS on runway 21R and MLS met Category 1 standards, the MLS represented a noticeable improvement in accuracy, signal quality, and flyability. Author

N91-32094# Aerospace Engineering and Research Associates, Inc., Landover, MD.

AUTOMATIC DEPENDENT SURVEILLANCE (ADS) PROGRAM SUMMARY

LONNIE H. BOWLIN, GUY T. GERMANA, and PETER L. MASSOGLIA (Federal Aviation Administration, Washington, DC.) In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 30-39 1991

Avail: NTIS HC/MF A19

The system architecture and components of a satellite data link based oceanic Air Traffic Control (ATC) System are discussed. Topics such as the role of the Aeronautical Telecommunications Network, the status of avionics development, and the International Civil Aviation Organization's (ICAO's) Automatic Dependent Surveillance (ADS) Panel efforts are addressed from an ATC perspective. Author

N91-32095# Federal Aviation Administration, Washington, DC.

SATELLITE COMMUNICATIONS (SATCOM) Project Summary

JOSEPH F. DORFLER In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 42-47 1991

Avail: NTIS HC/MF A19

The Federal Aviation Administration (FAA) Satellite Program consists of two complimentary activities: the Satellite Communications (SATCOM) Project and the Satellite Navigation (SATNAV) Project. The objectives of this program are twofold: to determine the capabilities of satellites for civil aviation, and to verify, test, and demonstrate applications of satellites, including Automatic Dependent Surveillance (ADS), within the National Airspace System (NAS). This paper introduces and overviews the SATCOM Project. The specific objectives of the SATCOM Project are to enhance the efficiency of Air Traffic Management (ATM) in oceanic airspace first and in the NAS later, and to enhance the efficiency of air carrier operations. To exploit satellite communication for maximum benefit of both the FAA and the Aviation community, the SATCOM Project is divided into three complimentary activities whose objectives are as follows: (1) to guide the development, test, and validation of national and international standards for the establishment and certification of the Aeronautical Mobile Satellite Safety (Route) Service (AMS(R)S); (2) to select and test, in cooperation with the aviation community, several satellite communications applications in key areas in order to demonstrate the substantial benefits gained by their implementation; and (3) to extend the benefits of satellite communications to general aviation through a study of the potential for future widespread use of satellite communications in the NAS considering the prospects of availability of new and innovative technologies and approaches to affect the desired benefits.

Author

N91-32096# International Civil Aviation Organization, Montreal (Quebec).

INTERNATIONAL STANDARDIZATION OF FUTURE AIR NAVIGATION SYSTEMS AUTOMATIC DEPENDENT SURVEILLANCE (ADS) ICAO ADS PANEL ACTIVITIES

FRANCISCO CASTRO-RODRIGUEZ In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 49-55 1991

Avail: NTIS HC/MF A19

To ensure safety, regularity, and efficiency of international civil aviation operations, international standardization is essential in all matters concerning the operation of aircraft and the facilities and services required such as aerodromes, telecommunications, navigation aids, meteorology, air traffic services, search and rescue, aeronautical information services, and aeronautical charts. Participation in this process of standardization by all countries is absolutely necessary. The International Civil Aviation Organization (ICAO) Council adopts (or amends when necessary) international standards and recommended practices and approves procedures for the safety, regularity, and efficiency of air navigation. The ICAO is actively involved in the evolutionary development of the Air Navigation System and in global implementation planning for the communications, navigation, and surveillance systems (CNS). Automatic dependent surveillance (ADS) is the key to improvements in air traffic management on a world-wide basis, and its development and implementation is being guided by ICAO through the Future Air Navigation (FANS) Committee (Phase 2) and panels of the Air Navigation Commission. Some of the topics covered include: (1) the role and function of the ICAO; (2) technical work and standardization; (3) regional planning and implementation; (4) future CNS systems; (5) ADS; (6) air traffic control automated systems based on ADS; (7) FANS-phase 2; and (8) related ICAO technical bodies. Author

N91-32097# Federal Aviation Administration, Washington, DC. International Procedures Branch.

INTERNATIONAL CIVIL AVIATION ORGANIZATION (ICAO) AUTOMATIC DEPENDENT SURVEILLANCE PANEL (ADSP) ACTIVITIES

W. FRANK PRICE and FAYE I. FRANCY (MiTech, Inc., Washington, DC.) In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 57-64 1991

Avail: NTIS HC/MF A19

Automatic Dependent Surveillance (ADS), with the Air Traffic Control (ATC) Automation Data Link, has the potential to upgrade

the efficiency and safety of ATC over much of the world's airspace. The system must be standardized to the extent that hardware and message formats are compatible, regardless of which satellite is being used. This maximizes the potential usefulness of the system and provides the motivation for international aircraft operators to equip their fleets with necessary avionics. But if only a few countries were to adopt the system, its potential usefulness would be reduced correspondingly. Some of the topics covered include: (1) the International Civil Aviation Organization (ICAO) ADS Panel's (ADSP's) terms of reference, work program, meeting agenda, and activities; (2) a definition of ADS; (3) operational requirements for ADS; (4) the effect of ADS on separation; (5) ADS-ATC communications procedures; (6) operational communication requirement; and (7) operational requirements for two-way pilot-controller communications for the effective use of ADS.

Author

N91-32098# Federal Aviation Administration, Washington, DC.

INTERNATIONAL PROGRAM SUMMARY

PETER L. MASSOGLIA and WILLIAM J. BUDURKA (MiTech, Inc., Washington, DC.) *In* FAA, The First Annual International Satellite Surveillance and Communication Symposium p 67-85 1991

Avail: NTIS HC/MF A19

The Automatic Dependent Surveillance (ADS) Programs of those countries which, in addition to the U.S., are most heavily involved in the operational implementation of ADS on an international basis are identified and described. The past and on-going International Civil Aviation Organization (ICAO) supported ADS activities that provide the overall guidelines for the individual country ADS Programs are also identified and described. Author

N91-32099# Federal Aviation Administration, Atlantic City, NJ.

AUTOMATIC DEPENDENT SURVEILLANCE PACIFIC ENGINEERING TRIALS

FRANK L. LORGE *In* *its* The First Annual International Satellite Surveillance and Communication Symposium p 95-100 1991

Avail: NTIS HC/MF A19

In 1988, the FAA initiated a cooperative program, called the Pacific Engineering Trials (PET), to evaluate the operational use of Automatic Dependent Surveillance (ADS) and the data link used to support it. The PET incorporates available equipment into a functional ADS prototype for the evaluation of the operational aspects of ADS. This program eases the transition from the current, manual system, to the fully automatic system of the future. Results will be used in developing the specifications for ADS components, and identifying operational and technical issues which must be resolved before the ADS System can become fully functional. These issues will be addressed in the development stage to ensure that the fielded system meets all operational requirements in an efficient manner. The PET Program is still in its early stages, but results are already being applied to the development of ADS and data link. The PET is one part of the overall FAA implementation strategy to improve the efficiency of oceanic air traffic control (ATC). The first step, certification of the avionics and limited use of the data link for sending ATC messages, is nearing completion. The PET are helping smooth the transition to the oceanic system of the future. This transition has already begun, resulting in changes to the way oceanic ATC is performed. This in turn provides benefits in terms of airspace and operational efficiency while maintaining the excellent safety record of oceanic air travel. Some of the topics covered include: (1) participants; (2) equipment; (3) FAA aircraft; and (4) data analysis. Author

N91-32100# Ministry of Transportation, Tokyo (Japan). Radio Engineering Div.

ADS (AUTOMATIC DEPENDENT SURVEILLANCE) PET (PACIFIC ENGINEERING TRIAL) PROGRAM IN JAPAN

HIROKI TAKEDA *In* FAA, The First Annual International Satellite Surveillance and Communication Symposium p 103-109 1991

Avail: NTIS HC/MF A19

Australia, the U.S., and Japan have agreed to initiate a cooperative Automatic Dependent Surveillance (ADS) Pacific Engineering Trial (PET) Program. The participating agencies are

the Australian Civil Aviation Authority (CAA), the U.S. FAA, and the Japan Civil Aviation Bureau (JCAB). The commercial airlines such as Quantas, United, Northwest, and Japan Airlines are going to participate in this ADS PET Program. Although the international standard for the Aeronautical Mobile Satellite Service (AMSS) and the ADS has not been finalized by the International Civil Aviation Organization (ICAO) yet, this ADS PET Program is expected to provide the opportunities concerning pre-operational experiences as well as various technical expertise for the development of these standards. The goals of this ADS PET Program are to resolve technical issues to gain operational experiences and to identify key issues related to the use of ADS. Some of the topics covered include: (1) system configuration; (2) data acquisition flow; (3) data analysis method; and (4) the program schedule. Author

N91-32101# Civil Aviation Authority, Canberra (Australia).

AUSTRALIAN EXPERIMENTS IN AUTOMATIC DEPENDENT SURVEILLANCE (ADS) INCLUDING THE PACIFIC ENGINEERING TRIALS (PET)

H. BRIAN OKEEFFE and GRAEME CHALLINOR *In* FAA, The First Annual International Satellite Surveillance and Communication Symposium p 111-115 1991

Avail: NTIS HC/MF A19

Japan, Australia, and the U.S. have agreed to a cooperative Automatic Dependent Surveillance (ADS) Trilateral Pacific Engineering Trials (PET) Test Program. The participating agencies are the Australian Civil Aviation Authority (CAA), the Japanese Civil Aviation Bureau (JCAB), and the U.S. Federal Aviation Administration (FAA). National carriers of the three countries are also involved. Two meetings were held to devise and agree on details of the test program. The ADS data are being received in Australia from some transpacific flights and exchanged between the agencies. Increasing amounts of data are expected as more aircraft with ADS capability are placed in service. Australia is also receiving ADS data from two domestic carriers via very high frequency (VHF) ACARS. The development of a general purpose display system is continuing. The displays can be driven by flight plans/pilot position reports, ADS data, or radar data. Prototypes are being placed in air traffic control (ATC) centers for evaluation. Some of the topics covered include: (1) the objectives of the ADS program; (2) the current status of the Australian Domestic Program; (3) the current status of the PET; and (4) future PET cooperation. Author

N91-32102# Air Navigation Technical Service, Paris (France). Advanced Systems Div.

FRENCH SATCOM PROGRAM AND RELATED INTERNATIONAL ACTIVITIES

PASCAL SENARD and PATRICE GAUTHIER *In* FAA, The First Annual International Satellite Surveillance and Communication Symposium p 119-124 1991

Avail: NTIS HC/MF A19

The work is described that the French Administration wishes to undertake, or is currently performing, in the field of satellite communications used for ATC purposes. The aim of this work program is to prepare the possible integration of a future Satcom-based ATC system, in consistency with the needs specific to the French Civil Aviation and in harmony with the approach adopted at an international level. The context is presented in which French ATC authorities have to deal with the emerging concept of satellite communications. A general presentation of the intended work program and of its successive steps is also included. Author

N91-32103# Aeronautical Radio, Inc., Annapolis, MD.

DIGITIZED VOICE TRIALS

TERESA A. ANDERSON *In* FAA, The First Annual International Satellite Surveillance and Communication Symposium p 127-131 1991

Avail: NTIS HC/MF A19

ARINC (Aeronautical Radio, Inc.) has the voice network architecture in place to support satellite voice communications today. By utilizing existing facilities and procedures, ARINC is able

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to facilitate rapid implementation of this new technology without adverse impact on system users. ARINC is working closely with the FAA to coordinate the oceanic communication evolution towards direct pilot-controller communications, whether by data or voice. The Digitized Voice Trials will evaluate ATC communication capabilities, define edge of satellite coverage and validate the performance of long duration calls. ARINC supports these efforts by providing the communication service, both in the satellite link and in the establishment of calls. ARINC also provides quality evaluation and assists in data collection. Author

N91-32104# Transport Canada Aviation, Ottawa (Ontario). Technical Services.

AUTOMATIC DEPENDENT SURVEILLANCE (ADS) DEVELOPMENT IN CANADA

NORMAN F. DIMOCK and DONALD F. MACLEAN /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 133-140 1991

Avail: NTIS HC/MF A19

Canadian work in progress to investigate operational and technical requirements for using ADS and data link in ATC is presented. Ongoing tests and experiments are described. North Atlantic ADS trials preparations are reported and some operational and technical issues are discussed. ADS-ATC Simulation plans are outlined. The notable features of ADS Development System workstations, to be used by controllers participating in ADS trials and simulations, are detailed. Author

N91-32105# Rockwell International Corp., Cedar Rapids, IA.

ADS COMMUNICATIONS: A CORNERSTONE

GEORGE A. COBLEY /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 143-148 1991

Avail: NTIS HC/MF A19

ADS Communications forms a cornerstone to the applications and communications networks of the 21st century. The need to communicate operational data between an aircraft and the Air Traffic Services is becoming focused and will lead to ever increasing applications. The obvious ones are the clearances and acknowledgements for oceanic operations, and the natural extension to domestic operations. A brief review of the development is presented, and the trial results are examined. Data are presented on the operational parameters that were collected at the Santa Paula Ground Earth Stations operated by COMSAT. It is shown that the operational signal parameters are statistically comparable to the early predictions. Author

N91-32106# Societe Internationale de Telecommunications Aeronautiques, London (England).

AERONAUTICAL MOBILE SATELLITE SERVICES

ESA-PRODAT/SITA AIRCOM SERVICE TRIALS PROGRAMME

GRAHAM C. LAKE, A. JONGEJANS, and P. NGUYEN (European Space Agency, Paris, France) /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 151-163 1991

Avail: NTIS HC/MF A19

In order to enhance its existing VHF AIRCOM service and in view of the potential development of satellite-based data communication services, SITA initiated plans for demonstrations and service trials of an Aeronautical Mobile Satellite Communications system for the benefit of its member airlines. For this purpose the ESA, INMARSAT, and SITA reached an agreement to carry out service trials using the existing MARECS satellite and based upon the development of the ESA PRODAT project. The PRODAT/AIRCOM Service Trials launched in late 1986 were successful and were expected to be completed by July 1991. The experimental work carried out by all involved participants is described briefly. Author

N91-32107# Computer Technology Associates, Inc., McKee City, NJ.

AERONAUTICAL MOBILE SATELLITE SERVICE (AMSS) MESSAGE AND VOICE ACCESS REQUEST TRANSIT DELAY

THOMAS F. DEHEL /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 181-190 1991

Avail: NTIS HC/MF A19

The development of standards for the use of satellite communications in aviation is supported by FAA. A preliminary analysis and simulation of the Aeronautical Mobile Satellite Service (AMSS) were conducted to determine message transit delay of the system under a range of conditions. The conditions include various message lengths, channel loading, channel data rates, and bit error rates. The simulations focused on the link level and physical levels; the effect of upper layer protocols were not considered as part of this initial effort. The simulation programs ADSSIM and SATSIM were provided which were used to generate results under a range of conditions. The distribution of the results is presented. Author

N91-32108# Ministry of Transportation, Tokyo (Japan). Radio Engineering Div.

SATELLITE DATA LINK RESEARCH AND DEVELOPMENT PROGRAM IN JAPAN

HIROKI TAKEDA /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 193-201 1991

Avail: NTIS HC/MF A19

In parallel with the Automatic Dependent Surveillance (ADS) Pacific Engineering Trail (PET) program which was initiated by Australia, U.S., and Japan, the research and development (R&D) program Satellite Data Link was promoted in Japan. Apart from ADS PET program, the Aircraft Earth Station (AES) and the Ground Earth Station (GES) to be used in this satellite data link R&D program are designed to be fully compatible with the ICAO AMSS Draft SARPs and INMARSAT SDM (System Definition Manual). The main purpose of this R&D program is to validate the bit oriented AMSS system based on the OSI (Open Systems Interconnection) model which is now under development in ICAO AMSSP (Aeronautical Mobile Satellite Service Panel). Author

N91-32109# ST Systems Corp., Lanham, MD.

SYSTEM IMPROVEMENTS IDENTIFIED BY THE NORTH ATLANTIC SYSTEMS PLANNING GROUP (NAT/SPG) AS RELATED TO THE CAPABILITIES OF THE OCEANIC DISPLAY AND PLANNING SYSTEM (ODAPS)

DAN H. IREDELL, RAJAN SRIRANGARAJAN, and JOHN H. CRIMMINS, JR. /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 221-230 1991

Avail: NTIS HC/MF A19

The main objective is to relate the current and projected capabilities of ODAPS to a set of the most demanding requirements included in the NAT/SPG system concept description. The following subject areas are covered: controller-pilot communications, position report processing, conflict prediction, and man-computer interfaces. Each of these subject areas are assessed relative to three environments: (1) non-ODAPS (i.e., the manual procedural environment that is currently dominant throughout the world); (2) ODAPS; and (3) ADS/data link (i.e., enhancements to ODAPS). Author

N91-32110# International Maritime Satellite Organization, London (England). Aeronautical Services Div.

INMARSAT ACCESS APPROVAL

JOHNNY NEMES /in FAA, The First Annual International Satellite Surveillance and Communication Symposium p 241-244 1991

Avail: NTIS HC/MF A19

The INMARSAT Access Approval Process is described that each new SATCOM installation type (i.e., Aircraft Earth Station - AES) must go through. The understanding of the INMARSAT approval process will help avionics and antenna manufacturers to plan the future activities required for timely and successful implementation of the ADS/SATCOM program. The objectives and details of the INMARSAT approval process and the testing required are described, including information on the entity that has the responsibility for leading the approval, the AES Integrator. A brief

description is presented of the commissioning tests that will be carried out on each example of an AES installation, of an access approved type, before entering service. Author

N91-32111# Communications Satellite Corp., Washington, DC. Aeronautical Services.

OPERATIONAL SATCOM: MOVING FROM TRIALS TO SERVICE

DAVID W. LIPKE and ELIZABETH YOUNG /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 247-251 1991

Avail: NTIS HC/MF A19

The INTELSAT system offers the capability for a network that could link area control centers (ACCs) and a host Inmarsat aeronautical ground earth station (GES). INTELSAT's Intelsat service can provide international data communication between a large INTELSAT station and microterminals at ACC locations. Concerning ocean air traffic management: the era of aeronautical satellite communications is opening with a rapid take-up by the corporate aviation community. The number of aircraft now equipped for voice service is growing steadily and greatly exceeds the number that have data capability. Satellites and ground earth stations to assist in the provision of improved ocean Air Traffic Control are in place and procedures for using the satellite network for delivering messages are well understood. Consideration should be given to supplementing terrestrial GES-ACC interconnect with a satellite broadcast mode type of signal for the dissemination of ADS reports to multiple ACC's. Author

N91-32112# Aeronautical Radio, Inc., Washington, DC. Civil Aviation Services.

THE FAA/ARINC INITIAL IMPLEMENTATION OF AMSS

ANGUS D. MCEACHEN, III /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 253-266 1991

Avail: NTIS HC/MF A19

The application of satellite based Communication Navigation and Surveillance (CNS) as defined by ICAO will provide significant cost benefits to the global air transport industry. The evolution is traced of Aeronautical Mobile Satellite Service (AMSS), the primary applications that are now targeted for use of AMSS are identified, and the series of phases of worldwide system transition from the current analog voice service to the future digital satellite communication service are described. Key implementation events that should take place for orderly transition to the future AMSS are also identified. A brief description of the current status of various trials and demonstrations of AMSS applications are also described. The improvements in Air Traffic Management (ATM) through the application of digital satellite based communication links offers the most cost efficient means to increase the quality and level of services offered and improve safety of operations while simultaneously lowering the overall system wide costs. Author

N91-32113# Societe Internationale de Telecommunications Aeronautiques, London (England).

SITA SATELLITE AIR COMMUNICATIONS IMPLEMENTATION

GRAHAM C. LAKE /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 269-274 1991

Avail: NTIS HC/MF A19

Societe Internationale de Telecommunications Aeronautiques (SITA) is introduced as a global aeronautical communications service provider. SITA operates the world's largest private telecommunications network, serving over 400 airlines in 190 countries. SITA provides VHF data link services in some 45 countries and a world wide voice and data Aeronautical Mobile Satellite Service (AMSS). The status and evolution of SITA AMSS is discussed, together with a review of Air Traffic Control use of SITA data link facilities. Author

N91-32114# Honeywell, Inc., Phoenix, AZ.

ADS INTEGRATION INTO THE FLIGHT MANAGEMENT COMPUTER

INGEBORG L. RAY /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 277-280 1991

Avail: NTIS HC/MF A19

The Aeronautical Telecommunications Network (ATN) Project is providing the aeronautical community with the first test environment for end-to-end bit-oriented communications. As a part of this project, current plans are for the Flight Management Computer (FMC) to provide the first avionics bit-oriented Automatic Dependent Surveillance (ADS) application process for the basic set of ADS messages. The FMS will use the necessary services of OSI communications protocols to support this first step of the FAA's Air Traffic Services (ATS) program. As more advanced steps of Air Traffic Services evolve, the navigational capabilities inherent in the FMS will allow for an optimal host environment. The initial role of the flight management function in Step One of the ADS services development is discussed along with the future capabilities of the FMC as avionics host for the expanding Air Traffic Management environment. Author

N91-32115# Stanford Telecommunications, Inc., Washington, DC.

USE OF ISO PROTOCOLS IN THE ADS ENVIRONMENT

STEPHEN P. VANTREES /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 283-292 1991

Avail: NTIS HC/MF A19

The International Organization for Standardization (ISO) protocols are presented which are currently used and envisioned for Automatic Dependent Surveillance (ADS) communications support. The Open Systems Interconnection (OSI) seven layer model as used in ADS is presented. The network layer protocols ISO 8473, ISO 9542, and ISO CD 10747 are presented. The transport layer protocol ISO 8073 is presented. The application layer protocols ISO 8650 and ISO 9072 are presented for information purposes. The benefit of ISO protocols in terms of interoperability and portability is important to the ADS program. The selection, profiling, implementation and fielding of these protocols is an important ongoing effort. Author

N91-32116# Federal Aviation Administration, Washington, DC.

NEAR-TERM SATELLITE-BASED OCEANIC AIR TRAFFIC CONTROL: GROUND SYSTEM DESCRIPTION

ELBERT J. HENRY and MARY A. MCCLARNON-MINNIX (Mitre Corp., McLean, VA.) /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 299-308 1991

Avail: NTIS HC/MF A19

A functional description is presented of the next generation of U.S. oceanic air traffic control ground automation system. The system will be based on the use of automatic dependent surveillance and data link communications between pilot and controller. A number of automation features will be provided to the controllers to take advantage of the surveillance and communications capabilities. The significant aspects are described of the surveillance, communications, and automation capabilities, and how the air traffic controller will operate in the new environment is illustrated. In addition, some background is given on the work of the FAA's Oceanic System Requirements Team of active oceanic controllers. Author

N91-32117# Mitre Corp., McLean, VA.

IMPACT OF AUTOMATION AND DATA LINK ENHANCEMENTS ON OCEANIC AIR TRAFFIC CONTROL

SABRINA F. SAUNDERS-HODGE and MARK H. RUNNELS /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 311-319 1991

Avail: NTIS HC/MF A19

Among other anticipated benefits, the implementation of Automatic Dependent Surveillance (ADS) is expected to facilitate significant improvements in the overall efficiency of oceanic air traffic control (ATC). The findings are presented of an analysis conducted to evaluate the potential impact of ADS on current oceanic ATC operations and procedures. Author

04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

N91-32118# Federal Aviation Administration, Washington, DC. **US OCEANIC AIR TRAFFIC CONTROL: PAST, PRESENT, AND FUTURE**

AMADO COLBERG /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 323-325 1991
Avail: NTIS HC/MF A19

A brief review is presented of oceanic air traffic control as it has been conducted in the U.S. The system improvements are described which are planned through the use of satellite communications technology, including air-ground data link and Automatic Dependent Surveillance (ADS). As nearly all of the oceanic airspace is outside of air traffic control (ATC) radar coverage, the oceanic ATC system has been characterized by the use of procedural nonradar separation. Further, most of the oceanic airspace is beyond the coverage of land based VHF communications, which is subject to line of sight limitations. Accordingly, it has been necessary to use High Frequency for air/ground/air communications. HF communications are relayed through commercial facilities dedicated to this purpose, which results in an additional delay in the ultimate reception of air traffic control messages. It is anticipated that the use of satellite relays will provide reliable and direct data link communications between controllers and pilots, eliminating the present communication delays. The use of ADS will provide continuous surveillance of oceanic air traffic on displays similar in appearance to ATC radar displays. Author

N91-32119# Mitre Corp., McLean, VA.

PRELIMINARY EVALUATION OF ADS/RADAR CORRELATION

CHRISTOPHER N. ANDREWS and LEONARD A. WOJCIK /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 327-334 1991
Avail: NTIS HC/MF A19

The potential utility, limitations, and implementation factors are addressed which are associated with the use of an Automatic Dependent Surveillance (ADS)/radar correlation function in an operational ADS system. The quality is also evaluated of surveillance data that could be obtained from ADS equipped flights and its suitability is assessed for oceanic automation by comparing engineering trials ADS data to radar data. Author

N91-32120# International Business Machines Corp., Gaithersburg, MD.

COOPERATIVE ADS/AAS INTEGRATION

CHARLES A. KENGLA and SHERMAN G. FRANCISCO /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 337-347 1991
Avail: NTIS HC/MF A19

Automatic Dependent Surveillance (ADS) offers the aviation community major new capabilities for serving air traffic in oceanic areas and other remote regions. For that potential to be fully realized, it is essential that the Federal Aviation Administration (FAA) Advanced Automation System (AAS) be fully integrated with ADS so that Air Traffic Control (ATC) services and communications based on ADS may be provided in a way similar to that now used in the radar environment. An overview of the AAS is presented. A suggested approach to providing an ADS interface with AAS is described, based on extending an existing AAS interface gateway module design while retaining the base distributed system concepts and standards. Author

N91-32121# Federal Aviation Administration, Atlantic City, NJ. Flight Test Branch.

OPERATIONAL OCEANIC AIR TRAFFIC CONTROL USING

SATELLITE DATA LINK: INITIAL IMPLEMENTATION

DONALD ARMSTRONG /In its The First Annual International Satellite Surveillance and Communication Symposium p 349-352 1991
Avail: NTIS HC/MF A19

The objective is the development of a phased transition plan for air traffic control (ATC) to utilize satellite data links and voice communication to service oceanic flights. Details of the transition plan implementation, data collection, and data reduction and

analysis are discussed. The first satellite communication based data link messages were exchanged in September, 1990. This trail demonstrated automatic and pilot entered messages and ground based uplink capabilities. Author

N91-32122# Federal Aviation Administration, Washington, DC. Research and Development Service.

FLIGHT OPERATIONS AND AIR TRAFFIC MANAGEMENT INTEGRATION

CLYDE A. MILLER and GEORGE C. CHANG /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 357-363 1991
Avail: NTIS HC/MF A19

Flight management systems are installed in many air carrier and business aviation aircraft for the purpose of assisting the flight crew in assuring a safe and efficient flight trajectory in accordance with the cleared flight plan. Recently the Federal Aviation Administration (FAA) launched a comprehensive research and development project focused on the use of air-ground data links for integrating the operation of airborne flight management automation. Integrated operation of flight management and air traffic management (ATM) automation appears to offer benefits for airspace users and ATM service providers. Author

N91-32123# IAT, Menlo Park, CA

AUTOMATIC DEPENDENT SURVEILLANCE BENEFIT AND COST ANALYSIS: INTERIM STUDY RESULTS

GEORGE J. COULURIS /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 371-375 1991
Avail: NTIS HC/MF A19

The results of an interim study of the economic and operational impacts of automatic dependent surveillance (ADS) are discussed. ADS will make provisions for satellite communications and advanced air traffic control (ATC) automation and will enhance air traffic services in oceanic and other airspaces. ADS will provide direct communication between pilots and air traffic controllers and enhanced ATC flight monitoring and airspace management capabilities. The benefit and cost study identified the operational benefits and implementation requirements of ADS and analyzed their potential impacts on users and providers of air traffic services. Potential safety benefits were qualitatively assessed, and potential cost savings due to ADS operations and implementation costs were quantitatively estimated. The study examined implementation and potential operational impacts for the North Atlantic and Pacific oceanic areas through the year 2010. The resulting estimated cost savings due to ADS exceed the estimated implementation costs. Author

N91-32124# Air Transport Association of America, Washington, DC.

SATELLITE SURVEILLANCE AND COMMUNICATIONS

AIRLINE BENEFITS: THE TELEPHONE MYTH

PAUL R. RYAN /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 379-383 1991
Avail: NTIS HC/MF A19

Given here is American Airlines' perspective on the requirements and benefits of installing satellite communications and Automatic Dependent Surveillance (ADS). Also discussed is the airline's approach to the satellite public telephone and flight safety issues. Their economic analysis suggests that the systems are cost justified. Author

N91-32125# Boeing Commercial Airplane Co., Seattle, WA. Flight Management Systems and Data Links.

COMMUNICATIONS NEEDS OF THE FUTURE AIR-GROUND INTERFACE

ANTHONY J. MARTIN and N. D. MOLLOY /In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 385-406 1991
Avail: NTIS HC/MF A19

The successful evolution of air ground data link applications is dependent on international cooperation and agreements to

establish the environment to provide economic returns to participating airlines and meet the safety requirements of the future air traffic control environment. The Boeing perspective on the future requirements for air/ground data links is given, with emphasis on the near term uses of SATCOM satellite communications. The current status of SATCOM systems on the 747-400 airplane is described together with the development efforts that are underway to achieve oceanic air traffic control via SATCOM data links by 1993. The design approach being taken for the new Boeing 777 airplane is also discussed.

Author

N91-32126# Computer Technology Associates, Inc., McKee City, NJ.

A MODEL HUMAN ENGINEERING APPROACH TO THE DEVELOPMENT OF REGULATORY STANDARDS FOR DIGITAL COMMUNICATION TECHNOLOGIES: DEFINING SAFETY FROM A HUMAN-MACHINE SYSTEMS PERSPECTIVE
RENATE ROSKE-HOFSTRAND, JACK BERKOWITZ, and ALBERT REHMANN (Federal Aviation Administration, Atlantic City, NJ.)
In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 409-418 1991
Avail: NTIS HC/MF A19

Outlined here is the initiation of a comprehensive research program that will investigate the integration of digital communications into the flightdeck and will address specific safety considerations. A basic research scheme, some preliminary results, and future directions are discussed. Results of the authors' Aviation Safety Reporting System (ASRS) data analysis indicate some typical human factors problems within the flightdeck. For example, pilots committed many omission errors during classically busy phases of flight, and these errors involved data entry into the flight management system (FMS) and other flightdeck systems. It is reasonable to expect that similar errors will occur in conjunction with a data link subsystem. In addition, the integration of the subsystem into the overall system may alter the procedural and operational human-machine and human-human relations in the cockpit. The role of the Federal Aviation Administration's airborne data link human factors effort is to provide inputs to certification. Through the decomposition and analysis of the flightdeck, recommendations can be formulated about proper integration practices. Included in these recommendations will be inputs about hardware/software design, sub-system integration, intra-cockpit procedures, and pilot-air traffic control integration procedures.

Author

N91-32127# Mitre Corp., McLean, VA. Center for Advanced Aviation System Development.

GROUND AUTOMATION PROCESSING OF NEAR-TERM OCEANIC ATC DATA LINK MESSAGES

YUEH-SHIU WU In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 433-442 1991
Avail: NTIS HC/MF A19

Effective use of data links requires computer aided message creation and processing to alleviate the additional workload associated with data entry for both pilots and controllers. Described here is how ground automation will process pre-defined fixed format oceanic data link messages in the near-term time frame. A message set consisting of message categories, message subcategories, and message types is proposed. Required characteristics for this message set are discussed. One downlink required message is traced as it goes through the various steps of ground automation processing and eventually becomes an air traffic control clearance message delivered to the pilot.

Author

N91-32128# Aeronautical Radio, Inc., Washington, DC. Advanced Satellite Systems Engineering.

EVALUATION OF OCEANIC FLIGHT DECK WORKLOAD AND ERROR REDUCTIONS THROUGH THE USE OF DATA COMMUNICATIONS

VIRGINIA WHITE and RICHARD E. HEINRICH In FAA, The First Annual International Satellite Surveillance and Communication Symposium p 445-452 1991
Avail: NTIS HC/MF A19

The use of oceanic data communications provides increased efficiencies to the flight deck for airline operation center/air traffic control (AOC/ATC) communications. Through the use of automated and semi-automated systems supported by data links, the flight deck can achieve both workload and error reduction. Furthermore, the data link can provide oceanic areas with improved error detection and tracking capabilities that can drastically improve the current system.

Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A91-53325

DROPPING THE PILOT

BERNARD FITZSIMONS Aerospace (UK) (ISSN 0305-0831), vol. 18, Sept. 1991, p. 8-10.
Copyright

A review is presented of RPV's, drones and other unmanned air vehicles in the U.K. The design, development and evolution of UAV's including the Falconet, Phoenix, and Raven RPV's are compared. Consideration is given to various powerplants; surveillance and target acquisition systems; launch and recovery methods; and mission sequence, timing, and navigation. Attention is given to the role of the mission controller, the air vehicle controller and the image analyst in the operational direction of the vehicle.

R.E.P.

A91-53554 Southwest Research Inst., San Antonio, TX.
PROBABILISTIC METHODS FOR ROTORDYNAMICS ANALYSIS

Y.-T. WU, T. Y. TORNG, H. R. MILLWATER, A. F. FOSSUM (Southwest Research Institute, San Antonio, TX), and M. H. RHEINFURTH (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991, 14 p. refs
(Contract NAS3-24389)
(SAE PAPER 911110) Copyright

This paper summarizes the development of the methods and a computer program to compute the probability of instability of dynamic systems that can be represented by a system of second-order ordinary linear differential equations. Two instability criteria based upon the eigenvalues or Routh-Hurwitz test functions are investigated. Computational methods based on a fast probability integration concept and an efficient adaptive importance sampling method are proposed to perform efficient probabilistic analysis. A numerical example is provided to demonstrate the methods.

Author

A91-53827

ADAPTIVE ACTIVE CONTROL OF SOUND FIELDS IN ELASTIC CYLINDERS VIA VIBRATIONAL INPUTS

D. S. MANDIC and J. D. JONES (Purdue University, West Lafayette, IN) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1552-1561. Previously cited in issue 13, p. 1943, Accession no. A89-33720. refs
(Contract NSF MSM-88-10384)
Copyright

A91-53857*# Douglas Aircraft Co., Inc., Long Beach, CA.
ENVIRONMENTAL CONSTRAINTS IMPOSED ON HIGH-SPEED CIVIL TRANSPORT (HSCT) DESIGNS

ALAN MORTLOCK (Douglas Aircraft Co., Long Beach, CA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, 7 p.
(Contract NAS1-19345)
(AIAA PAPER 91-3331) Copyright

This paper assesses airframe and engine technologies in terms of the preliminary environmental design goals for the HSCT. The preliminary goals are: (1) no adverse change in stratospheric ozone concentration caused by engine emissions; (2) meet FAR Stage 3 noise limits and operate within airport community noise exposure guidelines; and (3) minimize the environmental impact of overland sonic booms. The effects of design Mach number, low-emission combustors, engine fuel efficiency, and route structure are primary parameters affecting stratospheric emission effects. To minimize community noise, the engine cycle/noise suppression devices and high-lift devices must be developed, and operational procedures must be developed. To minimize the sonic boom impact, cruise weight, aircraft length, cruise altitude, and aircraft shape are the prime parameters to be considered. The detrimental effects of environmental constraints on aircraft operational costs are evaluated through tradeoff studies. Author

A91-53871* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

OVERVIEW OF THE NASA-SPONSORED HSCT PROPULSION SYSTEM STUDIES

WILLIAM C. STRACK (NASA, Lewis Research Center, Cleveland, OH) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs (AIAA PAPER 91-3329) Copyright

A brief overview of the NASA-sponsored HSCT propulsion system studies is presented that includes objectives, approach, schedules, and a summary of interim results highlighting the NASA in-house studies. Seven propulsion system concepts have been considered to date and comparatively evaluated on a first-order basis using takeoff gross weight (TOGW) as the main discriminator. Only two concepts have been screened out thus far and it is apparent that TOGW is not a strong discriminator. However, the first-order screening process did not account for differences in propulsion installation effects or climb-noise suppression penalties-both of which may strongly influence the screening process. Author

A91-53993

AIRCRAFT MISSION PROFILE - VIBRATION LEVELS

ROBERT BOOTLE (British Aerospace /Dynamics/, Ltd., Environmental Engineering Laboratories, Stevenage, England) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 528-530. refs Copyright

The paper is concerned with the vibration environment of an air-to-air guided weapon carried by a modern jet aircraft. The aim of the analysis is to estimate the fatigue damage under long-term steady flight conditions. The limitations of laboratory testing are discussed, and it is emphasized that an assessment of uncertainties is an essential part of the life cycle environmental profile considerations. V.L.

A91-54001

THE DERIVATION OF PROCEDURES TO ESTIMATE VIBRATION SEVERITIES OF AIRBORNE STORES

DAVID P. RICHARDS (Hunting Engineering, Ltd., Structural Dynamics Group, Amptill, England) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 679-687. Research supported by Ministry of Defence Procurement Executive. refs Copyright

The objective of the study reported here was to establish a basis from which vibration test specifications for airborne stores could be compiled. The overall program and its results are described. The parametric study included the development of a database catalog and database editing tasks as well as an evaluation of the effect of a variety of parameters on the vibration severities. An overview of the existing specifications is presented, and the proposed enhanced procedures are discussed. V.L.

A91-54003

PROCEDURES TO ESTIMATE VIBRATION SEVERITIES OF STORES ON HELICOPTERS

D. CHARLES (Cranfield Institute of Technology, England) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 694-701. refs Copyright

This paper presents results and conclusions from a recent parametric study on the vibration of stores carried externally on helicopters. Store vibration arising from helicopter speed and maneuvers, and the influence of different store carriage configurations is appraised. Using data from operational squadrons, variations in helicopter vibration severity, both between types and within a type, have been statistically evaluated. Detailed logic procedures for the derivation of environment descriptions and test specifications from measured flight data are presented. Also, fall-back severities suitable for design or testing purposes have been compiled. Author

A91-54004

CORRELATING RELIABILITY GROWTH VIBRATION TEST AND AIRCRAFT MISSION PROFILE VIBRATION LOADS AND EFFECTS

HANK CARUSO (Westinghouse Product Qualification Laboratory, Baltimore, MD) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 702-707. refs Copyright

A methodology is presented for correlating the vibration-induced fatigue stress accumulated during reliability growth testing (or any other form of vibration testing), with the anticipated fatigue stress accumulation during actual aircraft missions. A step-by-step process with accompanying example shows how generic mission profiles can be used as the starting point for performing this analysis. Using the Mach number/altitude time histories for each mission profile, aerodynamically-induced dynamic pressures and their relative frequency of occurrence are calculated. Using Miner's Hypothesis, this information is then normalized to establish fatigue equivalents for all mission phases compared to the most stressful phase. The results are then used to estimate Grms levels associated with flight conditions, and for comparison with the Grms levels applied during reliability growth testing. Author

A91-54010#

ON THE FEASIBILITY OF VERY LONG RANGE, SMALL CIVIL TRANSPORTS (VLRST)

J. ROSKAM and KYLE K. WETZEL (Kansas, University, Lawrence) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 20 p. refs (AIAA PAPER 91-3078) Copyright

The feasibility of a small, very long range transport is discussed from both technological and economical viewpoints. It is recommended that the technology choice made in the design of the VLRST be validated through a more detailed preliminary design effort; the technical feasibility of the single fuselage, transcontinental 'fallout' aircraft be investigated because the manufacturing cost estimates are based on the assumption of a high degree of commonality between two aircrafts/planes; and a comparative study with a conventional (single fuselage) design be made to determine the pros and cons of the twin fuselage configuration. O.G.

A91-54011#

VERY HIGH CAPACITY MEDIUM RANGE PASSENGER TRANSPORT

P. M. SAGDEO (Western Michigan University, Kalamazoo, MI) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. refs (AIAA PAPER 91-3079) Copyright

An account is given of the design features and performance characteristics of 1000-passenger, 3000-nautical mile range commercial aircraft capable of operating from airports currently accommodating B-747s. The markets addressed are those where passenger capacity is critical for airport congestion-relief but distances are moderate, as in the routes within East Asia, the continental U.S., and Western Europe. Aircraft weight and propulsion requirements would remain well within the limits of anticipated variants of the B-747. Several alternative fuselage cross-sections are considered. O.C.

A91-54012*# Purdue Univ., West Lafayette, IN.
**DESIGN OF A TURBOFAN POWERED REGIONAL
 TRANSPORT AIRCRAFT**

TERRENCE A. WEISSHAAR and CARL L. ALLEN (Purdue University, West Lafayette, IN) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 11 p. Research supported by NASA and Universities Space Research Association. refs
 (AIAA PAPER 91-3080) Copyright

The majority of the market for small commercial transport aircraft is dominated by high-efficiency, propeller-driven aircraft of non-U.S. manufacture. During the past year design teams responded to a Request For Proposal (RFP) for a regional transport aircraft. The RFP development identified promising world markets and their needs. Aircraft are designed with ranges of up to 1500 nautical miles and passenger loads between 50 and 90. During the design project, special emphasis was placed upon keeping acquisition cost and direct operating costs at a low level while providing passengers with superior comfort levels. This paper describes the background that led to this effort, and a brief description of some of the designs. Author

A91-54013#
REGIONAL FANJET AIRCRAFT OPTIMISATION STUDIES

LLOYD R. JENKINSON (Loughborough University of Technology, England) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs
 (AIAA PAPER 91-3081) Copyright

This paper illustrates the use of optimisation methods in the development of a new regional aircraft. A series of industrially-related design studies is presented. These include, the selection of the baseline configuration, various design sensitivity investigations, analysis of aircraft and engine stretch potential, and generalised (rubber engine) designs. The paper concludes with a discussion on the merits of optimisation studies in aircraft project design and offers some suggestions for changes to the strategies adopted. Author

A91-54021#
**A CONCEPT MISSION SENSITIVITY STUDY OF SEVERAL
 MEDIUM TO HIGH-SPEED V/STOL AIRCRAFT**

JOHN W. RUTHERFORD, STEVEN M. BASS, MARC A. LOVENGUTH, and ROBERT E. FITZPATRICK (McDonnell Douglas Helicopter Co., Mesa, AZ) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs
 (AIAA PAPER 91-3096) Copyright

A study investigating the sensitivity of high-speed rotocraft concepts to varying mission parameters was accomplished. This study included several candidate concepts ranging from tilting rotors and folding rotors, to stopped rotors. The mission parameters varied included range, speed, payload, and cruise altitude. Results show sizing trends for candidate concepts and their major subsystems as mission parameters vary. Concepts with integrated lift and propulsion systems demonstrate higher mission effectiveness over a wide range of air speed than those possessing separate systems. Subsystem weight sensitivities are depicted by an example focusing on the drive system. Author

A91-54023#
**VTOL/SP - A VERTICAL TAKEOFF AND LANDING VEHICLE
 SYNTHESIS PROGRAM**

P. P. CAMACHO (Douglas Aircraft Co., Long Beach, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p. refs
 (AIAA PAPER 91-3098) Copyright

VTOL/SP is a vehicle synthesis program developed specifically for vertical takeoff and conventional fixed-wing cruise aircraft. The method solves for the design optimization parameter (mission design gross weight) from a set of governing equations for the entire aircraft. It is set up to run interactively, so that solutions can be obtained quickly. The program has been used for parametric studies of the Advanced Technology Transport (ATT) and Spatial Operations Forces (SOF) aircraft. In-house trade studies are included to demonstrate the capabilities of the program. Author

A91-54026#
A VARIABLE GEOMETRY HSCT

D. W. ELLIOTT, R. D. HOSKINS, and R. F. MILLER (GE Aircraft Engines, Cincinnati, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs
 (AIAA PAPER 91-3101) Copyright

The oblique wing has the potential for improving the lift-to-drag ratio (L/D) in all of the High Speed Civil Transport operating regimes compared to a fixed-wing configuration. At takeoff a superior L/D is available with only a simple high-lift system on the unswept, high-aspect-ratio wing. This L/D addresses the noise constraints by ameliorating the suppression complexity of the nozzle. Assuming subsonic cruise over land is the answer to the sonic boom constraint, a 37 percent improvement in subsonic L/Ds will provide a more economic specific range. Finally, the design point L/D at Mach 2.4 is up 36 percent due to the higher wing loading and lower wave drag. The oblique wing can reduce the takeoff gross weight and engine size by 27 and 30 percent, respectively, and increase the return on investment by 15 percent. Author

A91-54028*# Boeing Commercial Airplane Co., Seattle, WA.
HSCT DESIGNS FOR REDUCED SONIC BOOM

GEORGE T. HAGLUND (Boeing Commercial Airplane Group, Seattle, WA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 17 p. refs
 (Contract NAS1-18377)
 (AIAA PAPER 91-3103) Copyright

The versatility of High Speed Civil Transports (HSCT) will be operationally limited by regulations that prohibit overland supersonic flight. This limitation gives impetus to the study of aerodynamic designs for reduced sonic boom. An HSCT design with an 'acceptable' sonic boom can allow routine overland supersonic cruise that would provide increased productivity and economic viability. During this four-year NASA-sponsored study, several configurations were designed for reduced sonic boom. An iterative technique was used in which the standard linear supersonic and Whitham sonic boom methods are extended. For the most severe sonic boom constraint of 72 dBA sonic boom loudness and 0.75 lb/sq ft shock strength at the ground, an economic benefit for operating at Mach 1.7 overland was not realized because of a decrease in the ratio of payload to takeoff gross weight. Additional design work is required to develop the best compromise between the low-boom requirements and optimum cruise performance. Author

A91-54029#
FEASIBILITY STUDY ON THE SECOND GENERATION SST

HIROSHI MIZUNO, SEI HAGIWARA (Japan Aircraft Development Corp., Tokyo), TOSHIO HANAI, and HIKARU TAKAMI (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 11 p. refs
 (AIAA PAPER 91-3104) Copyright

A parametric study is conducted for alternative next-generation

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SST sizes, passenger capacities, ranges, and cruise speeds, assuming the availability of variable-cycle engines of requisite thrust and environmental acceptability. Various route structures and traffic forecasts are invoked in the economic assessment of these options. Future SSTs fitting within the envelope of Mach 2.0 for 4500-6500 nautical mile ranges and Mach 2.5 for a 4500 nautical mile range are deemed capable of capturing about 90-percent passenger share. O.C.

A91-54030#

IMPROVING THE LIFT TO DRAG CHARACTERISTICS OF SST
KOJI MASUDA (Kawasaki Heavy Industries, Ltd., Aerospace Engineering Div., Gifu, Japan) and KENJI YOSHIDA (Kawasaki Heavy Industries, Ltd., Gifu Technical Institute, Japan) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. refs
(AIAA PAPER 91-3105) Copyright

Improving the lift-to-drag ratio of SST through aerodynamic design is vital if economically viable and environmentally acceptable SST is to be realized. Preliminary wind tunnel tests have been conducted on simplified configuration models which survey the typical drag reduction techniques, namely, wing planform, camber and twist, and area rule. Quantitative data about improving L/D have been acquired through the tests, and analytical calculations indicate fairly good agreement with experiments. Also, the CFD approach may provide new methods of optimizing L/D characteristics. These results encourage the belief that the target performance, L/D of 10 at Mach 2.5, is attainable. Author

A91-54033#

RELIABILITY AND REDUNDANCY REQUIREMENTS FOR NEXT-GENERATION VEHICLE MANAGEMENT SYSTEMS (NGENVMS)

WARREN WEINSTEIN and STANLEY MURN, JR. (Grumman Corp., Bethpage, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 7 p.
(AIAA PAPER 91-3109) Copyright

A vehicle-management system (VMS) embedded-survivability-mode safety function is described which can reduce the need for redundant hardware and verification and validation testing. The approach considers the reliability and redundancy requirements of three high-level aircraft modes and capability categories including lifetime safety, mission survivability, and weapons delivery. Flight-critical VMS functions are listed and VMS safety-system mechanization is discussed to develop next-generation VMS reliability/redundancy requirements. The design approach provides 100-percent fail-operational survivability modes and fail-safe modes depending upon mission type. The requirements in the three categories are applied to an example showing that the high-reliability-mode safety function can be used as an integral part of a fighter/attack aircraft which can fly at the extremes of the corresponding safety envelope. C.C.S.

A91-54037#

PRELIMINARY DESIGN OF A PRIMARY TRAINING AIRCRAFT

RAY WHITFORD (Cranfield Institute of Technology, Shrivenham, England) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 10 p. refs
(AIAA PAPER 91-3114) Copyright

The feasibility study performed for an aircraft to fulfill the anticipated USAF/USN Joint Primary Aircraft Training System is presented. A tandem-seating, single turbofan-powered aircraft equipped with low-cost, state-of-the-art avionics was designed in the initial stages. A part of the total design effort is reviewed and emphasis is placed on configuration development, aerodynamic design, powerplant selection and performance, weight breakdown, stability and control, and systems integration. R.E.P.

A91-54041#

THE TANDEM Y-WING - A NEW APPROACH TO STOPPED ROTOR V/STOL

SAMUEL J. CRAIG, GREGORY R. ZWERNEMANN, and JEFFREY

F. BLACK (Northrop Corp., B-2 Div., Pico Rivera, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. Research supported by Northrop Corp. refs

(AIAA PAPER 91-3120) Copyright

The present, 'stopped rotor' concept for a vertical-lift-capable transport aircraft has been derived from the database and experience obtained by X-wing and Advancing Blade Concept helicopter development programs. Two counterrotating three-blade main rotors are arranged in tandem in this configuration; propulsion and control system weights are conceptually minimized through the use of an integrated pneumatic propulsion/power transmission system that simplifies system integration. A 'helicruiser' transport concept incorporating this stopped-rotor concept is shown to promise unprecedented vertical-lift and payload/range capabilities for both commercial and military applications. O.C.

A91-54042#

V/STOL VS. CTOL PENALTIES AND PAYOFFS FOR NAVAL AVIATION

M. S. DAVENPORT, T. L. HELMSING, M. E. HENKE, G. W. LYERLA, S. D. RICHARDSON, D. W. ROBINSON, M. R. VAN DER VEER, and M. J. WILLIAMS (McDonnell Aircraft Co., Saint Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 6 p.
(AIAA PAPER 91-3122) Copyright

An evaluation is made of the comparative advantages of both CTOL and V/STOL naval aircraft in view of the totality of their operational requirements within the at-sea tactical aviation environment. Where applicable, the consequences of advanced technologies on current V/STOL operational penalties are assessed. Attention is given to advanced propulsion-system configurations being contemplated for supersonic speed-capable V/STOL as well as to the numerous basing modes possible for V/STOL. Basic insights into the character of V/STOL operations are gleaned from Harrier missions during Operation Desert Storm. O.C.

A91-54043#

RETRACTED ROTOR - LESSONS LEARNED FOR AIAA, AHS AND ASEE SYMPOSIUM

A. R. YACKLE AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs

(AIAA PAPER 91-3123) Copyright

A retracted-rotor configuration-design effort was conducted during the 1960s which established a high level of confidence for operations in which the rotor would be stopped in forward flight, folded, and stowed. Such an aircraft, in compound flight, would handle like a fixed-wing aircraft in virtue of the use of gyroscopically-stabilized controls. The retracted rigid rotor allowed for greater speed, disk loading, and autorotation qualities; the ability to fly and land either in rotary-wing or fixed-wing mode constitutes a 'built-in' safety feature for such aircraft. O.C.

A91-54045#

HIGH ALTITUDE RECONNAISSANCE AIRCRAFT

RENEE A. YAZDI (California State Polytechnic University, Pomona) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 11 p. refs

(AIAA PAPER 91-3125) Copyright

At the equator, the ozone layer ranges from 65,000 to over 130,000 feet which is beyond the capabilities of the ER-2, NASA's current high altitude reconnaissance aircraft. The Universities Space Research Association, in cooperation with NASA, is sponsoring an undergraduate program which is geared to designing an aircraft that can study the ozone layer. This aircraft must be able to satisfy four mission profiles. Mission one is a polar mission which ranges from Chile to the South Pole and back to Chile, a total range of 6000 nautical miles at 100,000 feet with a 2500-pound payload. The second mission is also a polar mission with a decreased altitude and an increased payload. For the third mission,

the aircraft will take-off at NASA Ames, cruise at 100,000 feet, and land in Chile. All four missions require that a subsonic Mach number be maintained due to constraints imposed by the air sampling equipment. Three aircraft configurations have been determined to be the most suitable for meeting the above requirements. The performance of each configuration is analyzed to investigate the feasibility of the project requirements. Author

A91-54046*# Kansas Univ., Lawrence.

A REVOLUTIONARY APPROACH TO GENERAL AVIATION AIRPLANE DESIGN

JAN ROSKAM and CHARLES GOMER (Kansas, University, Lawrence) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. Research sponsored by University of Kansas, NASA, and Universities Space Research Association. refs (AIAA PAPER 91-3126) Copyright

The accumulation of such advanced technologies as digital guidance/display concepts, flow laminarization techniques, smart structures, and composite primary structures, is presently considered systematically with a view to such novel features' integration in a next-generation general aviation aircraft. This Advanced Personal Transport is conceived as a six-passenger aircraft with 1200 nautical mile range; a tractor and a pusher configuration were considered, with the pusher configuration being of twin-boom empennage, three-lifting-surface type. Attention is given to pilot-workload reductions achievable through the proposed Integrated GPS/Glonass system. O.C.

A91-54058*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

UH-60 AIRLOADS PROGRAM - STATUS AND PLANS

ROBERT M. KUFELD and PAUL C. LOSCHKE (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3142) Copyright

The present paper addresses the background of the UH-60 Airloads Program, the instrumentation, data requirements, and the development of the data collection and storage systems. An outline of the data points to be collected and detail of data access are presented. The Outside Experiment Program, in which researchers outside of NASA propose potential flight experiments, is described. Attention is given to the development of research systems necessary to conduct the program. Significant improvements in data acquisition, processing, and storage quality are stated as the primary objectives as dictated from lessons learned during past rotor airloads flight research programs. P.D.

A91-54062#

DESIGN OF SWEEP BLADE ROTORS FOR HIGH-SPEED TILTROTOR APPLICATION

JOHN LIU and MICHAEL A. MCVEIGH (Boeing Helicopters, Philadelphia, PA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 13 p. refs

(AIAA PAPER 91-3147) Copyright

A method is described for performing the initial design of the chord, airfoil, twist and sweep distributions of high-speed propellers with swept blades. This method uses a blade-element/momentum theory approach and yields reasonable answers efficiently, thus making it suitable for propeller preliminary design. The swept blade propeller analysis is applied to the design of a 450 knot high-speed propeller. Results indicate a potential for up to 11 percent improvement in propulsive efficiency with only a slight degradation in hover efficiency. Author

A91-54076# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ADVANCED AIRCRAFT FOR ATMOSPHERIC RESEARCH

P. RUSSELL, S. WEGENER (NASA, Ames Research Center, Moffett Field, CA), J. LANGFORD (Aurora Flight Sciences Corp., Alexandria, VA), J. ANDERSON (Harvard University Cambridge,

MA), D. LUX (NASA, Flight Research Center, Edwards, CA), and D. W. HALL (David Hall Consulting, Sunnyvale, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3162) Copyright

The development of aircraft for high-altitude research is described in terms of program objectives and environmental, technological limitations, and the work on the Perseus A aircraft. The need for these advanced aircraft is proposed in relation to atmospheric science issues such as greenhouse trapping, the dynamics of tropical cyclones, and stratospheric ozone. The implications of the study on aircraft design requirements is addressed with attention given to the basic categories of high-altitude, long-range, long-duration, and nap-of-the-earth aircraft. A strategy is delineated for a platform that permits unique stratospheric measurements and is a step toward a more advanced aircraft. The goal of Perseus A is to carry scientific air sampling payloads weighing at least 50 kg to altitudes of more than 25 km. The airfoils are designed for low Reynolds numbers, the structural weight is very low, and the closed-cycle power plant runs on liquid oxygen. C.C.S.

A91-54079#

BENEFITS OF COMPOSITE STRUCTURE FOR THE TANDEM WING ADVANCED TECHNOLOGY TACTICAL TRANSPORT

WILLIAM E. BROWN and DARYL TIMMERMAN (Beech Aircraft Corp., Wichita, KS) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 10 p. Research sponsored by DARPA. refs (Contract DAAD05-89-C-9056)

(AIAA PAPER 91-3167) Copyright

The best design choices were determined for major airframe components of a 55,000 pound transport aircraft by a series of structural design studies. The speed of development, manufacturing complexity and weight are reviewed, using currently available materials and near term manufacturing methods. Large improvements in development time and structural weight are indicated for large cocured composite structure components. The composite structure concepts evolved from lessons learned during Beech's Starship experience. Author

A91-54080#

SPECIAL OPERATIONS AIRCRAFT NEEDS, OPTIONS AND FEASIBILITY

R. B. CHISMAN (Boeing Military Airplanes, Seattle, WA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 13 p. refs (AIAA PAPER 91-3168) Copyright

Results from studies intended to provide visibility into the options and design considerations for a new special operations aircraft (SOA) are presented. Mission requirements and design issues that influence the size of such an aircraft are discussed. Various systems concepts are described to define a broad view of the technology challenges for a VTOLSOA. R.E.P.

A91-54086#

AIRFRAME/ENGINE MECHANICAL INTEGRATION FOR HYPERSONIC AIRBREATHING AIRCRAFT

P. F. CASSIDY (McDonnell Douglas Corp., Saint Louis, MO) and S. M. HALLEY (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 5 p. refs (AIAA PAPER 91-3177) Copyright

The design challenges associated with mechanically integrating hypersonic airbreathing engines into ascent vehicles are identified, qualitatively evaluated and compared to the airframe/engine mechanical integration of traditional propulsion systems. The design process, including the use of CAD and FEM, and design objectives will be discussed first, followed by the major design challenges. The mechanical/structural integration design space for a hypersonic airbreathing engine will also be presented, including discussions of engine mounting, engine cycle options, and engine component packaging. Author

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A91-54089* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

BODY WEIGHT OF ADVANCED CONCEPT HYPERSONIC AIRCRAFT

MARK D. ARDEMA (NASA, Ames Research Center, Moffett Field, CA), ERIC J. TERJESEN (Santa Clara University, CA), CATHY D. ROBERTS (Sterling Software, Inc., Palo Alto, CA), and MARK C. CHAMBERS AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs

(AIAA PAPER 91-3180) Copyright

In this paper, preliminary qualitative and quantitative comparisons of the body weight of five hypersonic aircraft configurations are conducted. The five configurations are briefly described as follows: (1) a wing-and-body arrangement with a power-law, circular cross-section body and a delta wing; (2) an all-body vehicle with delta planform and elliptical cross-sections; (3) a wingless wave rider configuration; (4) a winged wave rider configuration; and (5) the spacewing concept, an oblique flying wing at low speed that yaws to 90 deg sweep and flies end-on at hypersonic speeds. The vehicles are defined by their external moldline geometries and by the interior arrangement of their fuel tanks and other components. Intersecting, circular-lobed tankage is used in vehicles with noncircular bodies. The nonusable volume of such concepts is calculated. The structural concept, structural materials, Thermal Protection System, and heat load are allowed to vary with vehicle longitudinal station. Relative strengths and weaknesses of the various hypersonic aircraft concepts in terms of body weight are summarized. Author

A91-54090#

DEVELOPMENT OF STOVL COMBAT AIRCRAFT

J. T. PLATT (British Aerospace /Military Aircraft/, Ltd., Preston, England) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. Research supported by Ministry of Defence Procurement Executive.

(AIAA PAPER 91-3183) Copyright

A comprehensive account is given of prospective modifications of the classic Harrier jump-jet configuration to improve range, cruise speed, maneuverability, and weapons load. Attention is given to both improved subsonic and fully supersonic flight-capable Harrier follow-ons, 'mixed' and 'unmixed' propulsion cycles, and powerplant vectorable thrust-apportionment alternatives. The possibility of supersonic cruise is a major goal of these configurational investigations. O.C.

A91-54092#

STOVL - GETTING THE COST BENEFIT TRADES RIGHT

IRVING E. WILKEN (DGI Engineering Technology, Washington, DC) and HAROLD ANDREWS AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 15 p. refs

(AIAA PAPER 91-3186) Copyright

General requirements of the aircraft carrier compatibility are examined together with the various approaches for determining how these carrier compatibility requirements translate into additional aircraft weight increments of the Navy CTOL aircraft and the high-performance jet STOVL aircraft. A consistent analysis approach to comparing CTOL and STOVL weight increments is defined, and the approach is used to compare the Navy CTOL and the STOVL. It was found that, for fighter/attack aircraft in the F/A-18 weight class, the empty weight fraction for carrier take off and landing enabling features is 15 percent for STOVL aircraft as compared with 7-10 percent for Navy CTOL aircraft. Near-term ATFE-based SSF designs have STOVL weight fractions of 8-12 percent. I.S.

A91-54093* Virginia Polytechnic Inst. and State Univ., Blacksburg.

MULTIDISCIPLINARY OPTIMIZATION IN AIRCRAFT DESIGN USING ANALYTIC TECHNOLOGY MODELS

BRETT MALONE and W. H. MASON (Virginia Polytechnic Institute

and State University, Blacksburg) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 15 p. refs

(Contract NAG1-224; NSF DDM-90-08451)

(AIAA PAPER 91-3187) Copyright

An approach to multidisciplinary optimization is presented which combines the Global Sensitivity Equation method, parametric optimization, and analytic technology models. The result is a powerful yet simple procedure for identifying key design issues. It can be used both to investigate technology integration issues very early in the design cycle, and to establish the information flow framework between disciplines for use in multidisciplinary optimization projects using much more computational intense representations of each technology. To illustrate the approach, an examination of the optimization of a short takeoff heavy transport aircraft is presented for numerous combinations of performance and technology constraints. Author

A91-54097#

HIGH ANGLE-OF-ATTACK FLIGHT CHARACTERISTICS OF THE YF-22

C. K. CLARK and M. R. BERNENS (General Dynamics Corp., Fort Worth, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 6 p. (AIAA PAPER 91-3194) Copyright

The YF-22 stealthy fighter employs thrust-vectoring engine nozzles to achieve unprecedentedly high levels of maneuverability at extreme angles of attack (AOAs). A high-accuracy vehicle data base encompassing engine-induced effects, engine thrust dynamic models, six-DOF aerodynamics, actuator models, and structural flexibility, has been used in a simulation program to design the requisite control laws; this has allowed the high-AOA flight test program to be completed in merely 10 flights. O.C.

A91-54098#

AERODYNAMIC DESIGN EVOLUTION OF THE SAAB 39 GRIPEN AIRCRAFT

KARL-ERIK MODIN and ULF CLAREUS (Saab-Scania, AB, Aircraft Div., Linköping, Sweden) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 19 p.

(AIAA PAPER 91-3195) Copyright

A review is presented of the aerodynamic development of the JAS 39 Gripen aircraft including a summary of the different aerodynamic layouts investigated leading to the short-coupled delta-canard layout. This single engine combat aircraft incorporates cross-sectional area distribution optimized for specific Mach number range, automatically actuated wing leading edge flaps, and trim function automatically balanced between canard and wing elevon for optimum performance. Attention is given to single versus twin engine selection, the flight control system, the pros and cons of various intake locations, and some flight test results. R.E.P.

A91-54368* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

TECHNIQUES USED IN THE F-14 VARIABLE-SWEEP

TRANSITION FLIGHT EXPERIMENT

BIANCA T. ANDERSON, ROBERT R. MEYER, JR., and HARRY R. CHILES (NASA, Flight Research Center, Edwards, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 622-629. Previously cited in issue 15, p. 2405, Accession no. A88-38762. refs

Copyright

A91-54369

FLIGHT TEST OF THE JAPANESE UPPER SURFACE BLOWING STOVL EXPERIMENTAL AIRCRAFT ASKA

HIROYUKI YAMATO (Tokyo, University, Japan), NORIAKI OKADA, and TOSHIO BANDO (National Aerospace Laboratory, Tokyo, Japan) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 630-637. Previously cited in issue 15, p. 2405, Accession no. A88-38750. refs

Copyright

A91-54372* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT TEST INVESTIGATION OF CERTIFICATION REQUIREMENTS FOR LAMINAR-FLOW GENERAL AVIATION AIRPLANES

G. S. MANUEL (NASA, Langley Research Center, Hampton, VA) and W. A. DOTY (Cessna Aircraft Co., Wichita, KS) *Journal of Aircraft* (ISSN 0021-8669), vol. 28, Oct. 1991, p. 652-656. Previously cited in issue 14, p. 2131, Accession no. A90-33920. refs Copyright

A91-54375

AIRCRAFT CONFIGURATIONS WITH OUTBOARD HORIZONTAL STABILIZERS

J. A. C. KENTFIELD (Calgary, University, Canada) *Journal of Aircraft* (ISSN 0021-8669), vol. 28, Oct. 1991, p. 670-672. refs Copyright

A configuration is proposed which allows the horizontal stabilizer (HS) to contribute significantly to the lift of the aircraft. The major feature of the arrangement is that each half of the HS is located outboard of a wingtip and thus lies within the upwash created by the wing and sustained by the wing trailing vortices. A preliminary analysis is presented which shows that significant lift-related drag reductions appear to be possible using an outboard configuration. A design example is presented. L.M.

A91-54393

LANDING GEAR - THE AIRCRAFT REQUIREMENT

S. J. GREENBANK (British Aerospace /Military Aircraft/, Ltd., Power and Mechanical Systems Engineering Dept., Preston, England) (Seminar on Landing Gear Systems, Solihull, England, June 26, 1990) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 205, no. G1, 1991, p. 27-34. Copyright

Trends in landing gear design, reflecting the developments in aircraft performance over the last two decades, are reviewed with reference to both civil and military aircraft. In particular, attention is given to such developments as carbon brakes, brake by wire, steer by wire, radial tires, and computer control. Key developments for the future are likely to be driven by civil STOL and military ASTOVL requirements and will include advanced suspension, increased tire flotation, tire/brake/pressure/temperature monitors, versatility in operation, lower mass/volume ratios, longer life, and lower support costs. V.L.

A91-54701

REMOTELY PILOTED VEHICLES; INTERNATIONAL CONFERENCE, 8TH, BRISTOL, ENGLAND, APR. 2-4, 1990, PROCEEDINGS AND SUPPLEMENTARY PAPERS

Conference sponsored by Royal Aeronautical Society, IEE, and University of Bristol. Bristol, England, University of Bristol, 1990, p. Proceedings, 159 p.; Supplementary Papers, 36 p. For individual items see A91-54702 to A91-54721.

Copyright

This conference presents papers in the fields of fixed wing systems, payloads, rotary wing VTOL, and aerodynamics. Also presented are ground station and support equipment, propulsion subsystems, navigation and guidance, and communication systems. R.E.P.

A91-54707

POSSIBLE ROTORCRAFT CONFIGURATIONS FOR UNMANNED APPLICATIONS

D. V. HUMPHERSON (Westland Helicopters, Ltd., Yeovil, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 10.1-10.15.

Copyright

A study was conducted to investigate the potential for VTOL UMA solutions to meet a range of requirements including a high-speed, large payload mission, and a low-speed/hover, large payload mission. Consideration is given to advanced configurations

that include tilt-rotor vehicles, thrust compounded helicopters, and lift/thrust compounded helicopters. It is concluded that for the high-speed, large payload mission, the tilt-rotor was most suitable. R.E.P.

A91-54710

THE SPRITE SYSTEM - AN UPDATE

R. G. AUSTIN and P. A. RYRIE (ML Wallop Defence Systems, Ltd., Andover, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 13.1-13.13.

Copyright

Various aspects of the continuing development and tests of the Sprite system during the past 18 months are presented. Achievements in shipborne operation and the use of low light level television with a VTOL RPV are discussed with some environmental lessons learned and incorporated. R.E.P.

A91-54712

DEVELOPMENT AND TESTING OF A HIGH ASPECT RATIO WING

ANGELO C. GUARINO, JR., CHRISTIAN E. FISHER, and RICHARD C. EKLUND (Locus, Inc., Alexandria, VA) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 15.1-15.9.

(Contract N00014-86-C-2529)

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Development and testing of the Low Altitude Unmanned Research Aircraft (LAURA) tandem wing vehicle configuration that uses a Wortmann FX63-137 airfoil for the high aspect ratio (26.7) forward wing is presented. Specific techniques applied to the fabrication of the wing, and the extent of correlation obtained between the analytical methods and the proofloading tests are discussed. It appears possible to achieve excellent strength-to-weight ratios for high aspect ratio composite wings utilizing hand lay-up methods if special tools and fabrication techniques are developed. R.E.P.

A91-54720

SCALE MODELS FOR MEASUREMENT OF AIRCRAFT ACOUSTIC NOISE

PHILIPPE BATAILLE (Service de la Formation Aeronautique et du Controle Technique, Paris, France) and ALAIN DEPITRE (Service Technique de la Navigation Aerienne, Paris, France) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Supplementary Papers. Bristol, England, University of Bristol, 1990, p. 6.1-6.5.

Copyright

An overview in the field of noise measurements conducted for the purposes of aircraft acoustic certification is presented. Noise levels are determined for both reference aircraft procedures and related atmospheric conditions using a remote sounding system carried by RPVs. R.E.P.

A91-55448

TITANIUM MATRIX COMPOSITE LANDING GEAR TESTING

Aerospace Engineering (ISSN 0736-2536), vol. 11, Oct. 1991, p. 11-15.

Copyright

An F-15 fighter's nose landing gear main cylinder has been constructed from a continuously reinforced Ti-matrix composite (TMC) which exhibits nearly twice the structural efficiency of high-strength steel while possessing excellent resistance to environmental degradation. Attention is presently given to the results of static structural tests and functional evaluations of the resulting nose-gear assembly. The structural tests encompassed the three critical-load conditions of towing, cosine dip, and jacking. The structural integrity of the TMC and the life of the nickel plating on the cylinder bore far exceeded expectation. O.C.

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A91-55449

X-29A - HIGH-ANGLE-OF-ATTACK TESTING

Aerospace Engineering (ISSN 0736-2536), vol. 11, Oct. 1991, p. 17-19.

Copyright

The NASA/USAF X-29A flight-envelope expansion efforts have proceeded to demonstrate the aircraft's capacity for full maneuvering flight up to $\alpha = 40$ deg, as well as for symmetric pullups or pitch-pointing to $\alpha = 70$ deg. Moderate-intensity buffet became apparent at α between 13 and 22 deg. Although maximum roll rate was about 30 deg/sec, proverse rudder significantly enhanced that rate. Controllable maneuvering has been demonstrated up to the maximum coefficient of lift despite the fact that leading-edge flaps and thrust vectoring are not used, thereby constituting an exceptionally simple system for the demonstrated capabilities. O.C.

A91-55450

IS THERE PRACTICAL HIGH-SPEED VTOL IN THE FUTURE?

Aerospace Engineering (ISSN 0736-2536), vol. 11, Oct. 1991, p. 21-24.

Copyright

A comprehensive comparative evaluation is presented for the range of VTOL aircraft configurational possibilities conceived to date whose cruise speed potential is substantially greater than that of conventional helicopters without compromising hovering efficiency. Attention is given to Advancing Blade Concept helicopters, tilt-rotors, variable-diameter and folding tilt-rotors, tilt-wings, fan-in-wings, lift-fans, X-wings, and thrust-downvectoring alternatives. The variable-diameter tilt-rotor concept appears to achieve both hovering efficiency and high cruise-speed objectives. O.C.

A91-55451

AIRCRAFT DESIGN EXPERIENCE

SHIZUO KIKUHARA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, Aug. 1991, p. 379-387. In Japanese.

The design experience of the author who participated in 11 kinds of aircraft designs from the 1930's to the 1960's are presented. Four major designs of aircraft are emphasized including the H6K1 and H8K1, the N1K2-J, and the PS-1. Y.P.Q.

A91-55694

KAMOV KA-62 - THE NEW SOVIET HELICOPTER FOR THE 1990'S

VENIAMIN A. KAS'IANIKOV (Kamov Helicopter Co., Moscow, USSR) Vertiflite (ISSN 0042-4455), vol. 37, Sept.-Oct. 1991, p. 54-58.

Copyright

A review is presented of a new multipurpose civil helicopter, seating 14 to 16 passengers, incorporating the very latest technology and design features. The Ka-62 is a single-rotor craft with a fan-in-fin tail rotor to counteract torque and provide directional control. The tail boom is constructed of composite material by filament winding technique and has a fairing accommodating the tail rotor transmission shaft, the directional control linkage, and the hydraulic system tubing. Attention is given to performance specifications, general dimension specifications, avionics, and mission configurations. R.E.P.

A91-56098

SSBJ - A TECHNOLOGICAL CHALLENGE

H. S. BRUNER (Gulfstream Aerospace Corp., Savannah, GA) ICAO Journal (ISSN 0018-8778), vol. 46, Aug. 1991, p. 9-13.

Copyright

A U.S. business jet manufacturer has teamed up with the USSR's Sukhoi Design Bureau to design, develop, certify, and manufacture the world's first supersonic business jet (SSBJ). A set of preliminary requirements has been developed which addresses the market's need for fast/long-range business transportation; simultaneous feasibility studies show, however, that current technology cannot meet both weight and performance

requirements. Technologies are identified in which improvements would have direct SSBJ-enabling consequences. Sukhoi has already initiated wind tunnel testing of a candidate SSBJ configuration. O.C.

A91-56105

LOW OBSERVABLE PROPULSION DESIGN

ALAN C. BROWN (Lockheed Corp., Calabasas, CA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 54-61.

Copyright

The two most important observables to the military aircraft designer are radar and infrared. Because of its range, frequency bandwidth and all-weather capability, radar receives considerably more attention, and is given proportionate emphasis in this paper. Some basic principles of radar returns from canonical objects are reviewed. Then, coatings and absorbers, high temperature effects, and jet wakes are considered. This is followed by a short discussion on infrared radiation. The second part of the paper is devoted to examples from three different eras, the SR-71, the F-117A and the F-22. In each case, the approach to reduction of propulsion system observables is discussed thoroughly, but for obvious security reasons, the numerical results are not. Author

A91-56227

THE DEVELOPMENT OF A REDESIGN PROCEDURE FOR CIVIL ENGINE NACELLES

R. V. BROOKS, N. T. BIRCH, and E. H. KITCHEN (Rolls-Royce, PLC, Derby, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1177-1183. refs

Copyright

A combined analysis and redesign method for axisymmetric subsonic engine nacelles is presented. The procedure is based on an approximate factorization solution of the axisymmetric full potential equation, capable of dealing with transonic flow. Changes to the nacelle shape are modelled using surface transpiration. An influence matrix is calculated which summarizes the relationship between small changes in surface transpiration and changes in the surface pressure distribution. The target pressure distribution is modified iteratively to ensure that the redesigned surface blends with the original surface outside the redesign region. The program is fast and interactive. Several examples are given to illustrate how the program can be used in practical nacelle design. Author

A91-56228

ADVANCED DUCTED ENGINES NACELLE AERODYNAMICS AND INTEGRATION TESTING

P. TRACKSDORF, K. HEINING (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany), and J. E. MCCALL (Pratt and Whitney Group, East Hartford, CT) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1184-1191.

Copyright

Future aircraft engine development may lead to advanced ducted engines which have a bypass ratio significantly higher than present turbofans. The increases in bypass ratio will dictate larger diameter nacelles and an increasing importance of the nacelle aerodynamics and wing integration aerodynamics. A series of isolated wind tunnel tests was therefore designed and conducted to investigate inlet, nozzle and reverser aerodynamics. Key features of the tests are noted and significant results are discussed. Author

A91-56229

MECHANICAL NACELLE DESIGN FOR ADVANCED DUCTED ENGINES

B. J. STRAUSS (Rohr Industries, Inc., Chula Vista, CA), H. A. GEIDEL, and A. ROHRA (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1192-1198. refs

Copyright

The next generation of commercial aircraft engines will be designed for superior overall economics, while setting new standards for performance and efficiency. The best approach to meet these requirements will be high bypass ratio advanced ducted engines (ADE) which introduce a variety of parameters controlling overall system optimization and pose unique challenges in mechanical and structural design. The structural components of the nacelle and systems, and their efficient integration, present major design challenges. Increased nacelle dimensions demand light weight, low cost and low drag design innovations; they also introduce higher resultant loads, and increase requirements for stiffness and deflection control. Author

A91-56230

AN AUXILIARY INTAKE SYSTEM FOR AN UNMANNED AIRCRAFT

A. M. ABDEL-FATTAH and S. A. FISHER (Defence Science and Technology Organisation, Aeronautical Research Laboratory, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1199-1208. refs

Copyright

Results are presented of an R&D program to improve the take-off performance of an unmanned target aircraft powered by a turbojet engine, using an auxiliary intake system which is deployed during take-off. The concept was explored theoretically and was verified with model scale experimental testing of the air intake duct, both statically and at simulated aircraft take-off conditions in a wind tunnel. The sensitivity of measured pressure recovery at the engine face was established with respect to auxiliary intake aperture size, aspect ratio, lip profile, and door configuration, over a range of forward speed and incidence. The tests showed that substantial improvements in pressure recovery, with acceptable levels of flow distortion at the engine face, can be achieved with practical modifications to the air intake duct. Author

A91-56641

FOXHOUND - SON OF FOXBAT

ROY BRAYBROOK Air International (ISSN 0306-5634), vol. 41, Sept. 1991, p. 121-126, 130.

Copyright

A review is presented of the design, development and performance specifications of the Mikoyan fighter aircraft series leading up to the present Mig-25 Foxbats and the latest Mig-31 Foxhound. This current version is described as a relatively heavy though well powered interceptor that expands significantly on the speed-altitude envelope of the Mig-25, benefiting from a new generation radar, a two-man crew, and enhanced armament. The powerplant consists of two afterburning turbofans, each rated at 34,170 lb with afterburner. Aircraft maximum speed is Mach 2.83 up to 57,400 ft and maximum endurance of 3.6 hr with external tanks; service ceiling is given as 67,600 ft. R.E.P.

A91-56822

SURFACE MODELLING OF A FIGHTER AIRCRAFT FUSELAGE WITH B-SPLINE SKELETAL LINES

M. ABRAMIAN, S. BEDI (Waterloo, University, Canada), and P. KANKAINEN Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 37, March 1991, p. 35-41. Research supported by NSERC. refs

A method for B-spline surface interpolation and its application to generate a computer model of a fighter aircraft is presented. The interpolation method is a recursive technique that can be employed to interpolate Bezier and B-spline surfaces and curves.

Due to the severe discontinuity at the intake section of the fuselage, the total surface is modeled as two separate (aft and forward) sections with point and slope continuity across the junction. The capability of this technique is demonstrated successfully replicating the canopy region and the air intake region of the aircraft.

R.E.P.

N91-31125# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.

PHOTOELASTIC COATING STUDY OF REDESIGNED CT114 COUPON JOINT TEST SPECIMEN FOR HORIZONTAL STABILIZER REAR ATTACHMENT FITTING TO VERTICAL STABILIZER REAR SPAR

J. P. KOMOROWSKI 15 Mar. 1989 13 p
(NAE-LTR-ST-1701; CTN-91-60026) Copyright Avail: NTIS HC/MF A03

As part of a program of life extension for the CT-114 aircraft, an experimental investigation was initiated of the durability and damage tolerance of the horizontal stabilizer rear attachment fitting and its attached components from the vertical stabilizer rear spar in the tail assembly. Photoelastic studies under static loads were carried out. Specimens from earlier studies were used with redesigned fasteners to provide more representative transfer of load through the structure. A strain survey was carried out to see if significant slippage and redistribution of strain occurred depending on the type of fastener used. The fastener installations were shown to result in large tensile strains to the doubler plate. It was recommended that further tests be carried out with fastener pitch increased and a full width doubler used to better simulate the structure. CISTI

N91-31126 Beech Aircraft Corp., Boulder, CO.

METHOD FOR FASTENING AIRCRAFT FRAME ELEMENTS TO SANDWICH SKIN PANELS COVERING SAME USING WOVEN FIBER CONNECTORS Patent

PAUL J. JONAS, inventor 18 Sep. 1990 25 p
(PATENT-1-274-075; INT-PATENT-CLASS-B64C-318; CTN-91-60135) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

An invention for joining frame elements to fibre reinforced composite skin panels is described. It is comprised of a three dimensional woven fiber strap or band of H-shaped cross section which takes maximum advantage of the ability of the yarn strands of endless filament bundles to carry large tension loads. The crossbar portion of the H projects laterally beyond the upright portion. It forms the means for bridging the gap formed on the inner face of a skin panel when a groove is routed adjacent to the frame element which is to be fastened. Strands of the crossbar section are adhesively bonded to the inner facesheet adjacent to the groove edges reestablishing its continuity across the joint. The upright portion of the strap likewise establishes an adhesively bonded woven bridge interconnecting the edges of the core exposed at the sides of the groove in the skin panel and the faces of the frame element. Any chordwise bending load tending to widen the gap in the inner facesheet is resisted by the filaments in the crossbar section. Any load tending to pull the spar out of the channel formed by the crossbar and upright portion of the H is resisted by the entire upright portion of the H connector. The joint thus formed can give way only by breaking or stretching the adhesive bond. CISTI

N91-31127 Grumman Aerospace Corp., Bethpage, NY.

TORSION RESISTANT GROOVED JOINT Patent

ALDO ARENA, inventor and ROBERT L. BENOIT, inventor 22 Aug. 1989 11 p
(PATENT-1-258-589; INT-PATENT-CLASS-F16B-400; CTN-91-60164) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

Torque or torsion members are commonly used in aircraft or aerospace vehicles by connecting the ends of a tubular member to a preformed member adapted to fasten the assembled torsion

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member to the elements between which torque or torsion is to be transmitted. This allows a substantial reduction of the overall weight of the assembly. This invention provides a torque tube assembly wherein the torsional strength of the end connection exceeds the torsional strength of the tube comprising a pair, or end members interconnected by a tubular member. The grooving and forming arrangement of a pushrod are adapted to torque or to torsion transmitting tubes, and a member is produced such that the torsion strength of the tube at the end connection exceeds the torsional buckling and failure strength of the tube itself. The invention is obtained by extending the grooves axially of the tube, and by maintaining the groove side walls at an angle within prescribed limits; the number of grooves to the outer diameter of the end fitting and groove width at a prescribed ratio; the groove depth to the groove width at a prescribed ratio; and the axial length of the grooves longer than the circumferential groove width. CISTI

N91-31128 Kansas Univ., Lawrence.
FIGHTER AGILITY METRICS Ph.D. Thesis
RANDALL KEITH LIEFER 1990 206 p
Avail: Univ. Microfilms Order No. DA9119093

Proposed new metrics to assess fighter aircraft agility are collected and analyzed. A framework for classification of these new agility metrics is developed and applied. A complete set of transient agility metrics is evaluated with a high fidelity, nonlinear F-18 simulation provided by NASA-Dryden. Test techniques and data reduction methods are proposed. A method of providing cuing information to the pilot during flight test is discussed. The sensitivity of longitudinal and lateral agility metrics to deviations from the pilot cues is studied in detail. The metrics are shown to be largely insensitive to reasonable deviations from the nominal test pilot commands. Instrumentation required to quantify agility via flight test is also considered. With one exception, each of the proposed new metrics may be measured with instrumentation currently available. Simulation documentation and user instructions are provided in an appendix. Dissert. Abstr.

N91-31129 Oklahoma Univ., Norman.
MODEL OF AN AEROSPACE PLANE BASED ON AN IDEALIZED CONE-DERIVED WAVERIDER FOREBODY Ph.D. Thesis
HYUNG-KOO PARK 1990 161 p
Avail: Univ. Microfilms Order No. DA9119180

The flow field of an idealized cone-derived waverider is axisymmetric. This feature is preserved for the rest of the vehicle, including the inlet, cowl, combustor, and nozzle. Researchers thus have a tip to tail model in which both the external and internal flows are axisymmetric. The assumption of axial symmetry provides a major simplification for the analysis and allows for a systematic integration of the propulsion unit with the aerodynamics. A novel design concept is used for the nozzle that avoids shock waves, minimizes the nozzle length, and tends to maximize the thrust. The model is designed to provide lift, thrust, drag, and fuel consumption data for a vehicle cruising at a hypersonic Mach number. Despite its idealized, inviscid limitations, it provides a reasonably self-consistent representation of both the aerodynamics and the scramjet/nozzle powerplant of the vehicle in a fully integrated configuration. In addition to describing the model, a range of parametric studies are presented. Dissert. Abstr.

N91-31130# Aeritalia S.p.A., Turin (Italy). Defence Aircraft Group.
INLET EDGE FUNNEL OF A CIVIL AIRCRAFT GONDOLA ENGINE [IMBUTITURA DEL BORDO DI ENTRATA DI UNA GONDOLA MOTORE DI UN VELIVOLO CIVILE]
A. FORMISANO and G. L. RAFFETO (Espri MARC, Genoa, Italy) 1990 40 p In ITALIAN Presented at the Conferenza Italiana degli Utenti MARC, Padua, Italy, 27-28 Sep. 1990 (ETN-91-99775) Copyright Avail: NTIS HC/MF A03

A finite element code to investigate the elastoplastic behavior of the aluminum material Al 2219T0 for its application in an inlet edge funnel is presented. The structure and forming processing

are outlined. The geometry of the problem is described. The results agree with experimental and theoretical predictions. ESA

N91-31131# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

DESIGN AND TESTING OF A MULTIBLOCK GRID-GENERATION PROCEDURE FOR AIRCRAFT DESIGN AND RESEARCH

J. W. BOERSTOEL, J. M. J. W. JACOBS, A. KASSIES, A. AMENDOLA, R. TOGNACCINI, and P. L. VITAGLIANO (Aeritalia S.p.A., Turin, Italy) 19 May 1989 21 p Presented at 64th AGARD Fluid Dynamics Panel on Applications of Mesh Generation to Complex 3D Configurations, Loen, Norway, 24-25 May 1989 Previously announced as N90-21984 (Contract NIVR-1604N) (NLR-TP-89146-U; ETN-91-99643; AD-B153480L) Avail: NTIS HC/MF A03

A multiblock grid generation procedure embedded in a numerical flow simulation system is described. Major features of the grids are: they are suitable for complex aerodynamic configurations; the grid lines are continuous, in particular, over block faces; the grid lines are not slope-continuous over block faces; the topology and geometry of block decomposition are specified first, and then the grid-point distributions; the application and transfinite interpolation and elliptic techniques. It is possible to construct multiblock grids around complex configurations with 250 to 1000 blocks, and to computer (Euler) flows on such grids. New technical concepts are proposed, to improve the accuracy of the flow simulation results, and to reduce manhour investments in the construction of multiblock grids. ESA

N91-31132# National Aerospace Lab., Amsterdam (Netherlands).

ACTIVITIES REPORT OF THE NATIONAL AEROSPACE LABORATORY Annual Report, 1989 [STICHTING NATIONAAL LUCHT- EN RUIMTEVAARTLABORATORIUM: VERSLAG OVER HET JAAR, 1989]

1989 110 p In DUTCH
(ETN-91-99438) Avail: NTIS HC/MF A06

Theoretical and numerical methods were developed for the investigation of the aerodynamics of new configurations. Flight tests were performed for the evaluation and certification of the Fokker 50 and Fokker 100. Aircraft structures and materials were tested. Instrumentation for astronautical applications was developed. Software and hardware were developed for applied informatics. Technical equipment was developed for flow studies, flight mechanics research, constructions and materials, aeronautical research, applied informatics, and mechanical techniques. ESA

N91-31133# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.

FLIGHT TESTING IN THE NETHERLANDS: AN OVERVIEW

J. T. M. VANDOORN and R. L. VANDERVELDE 1 Sep. 1988 29 p Presented at the 73rd AGARD Flight Mechanics Panel-Symposium on Flight Test Techniques, Edwards Air Force Base, CA, 17-20 Oct. 1988 (NLR-MP-88053-U; ETN-91-99654; AD-B153868L) Avail: NTIS HC/MF A03

An overview of the flight test activities and capabilities in the Netherlands is given. A general description of the flight tests programs of the last decades with civil and military aircraft, helicopters and research aircraft is given. Some of the highlights of the more recent programs are presented, i.e., the type certification of the Fokker 50 and Fokker 100 civil transport aircraft, evaluation and certification trials with the military F216 fighter aircraft, helicopter ship compatibility testing and the determination of the mathematical model of the Cessna citation 500 for the phase 2 flight simulator. Furthermore a short description of the flight test instrumentation and flight test techniques that have become available in the Netherlands during the last decade is given. ESA

N91-31134# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).

NOXIOUS MATTER MINIMIZATION AS A PROJECT CRITERION FOR AIRCRAFT [SCHADSTOFFMINIMIERUNG ALS ENTWURFSKRITERIUM FUER FLUGZEUGE]

HORST PREM 1990 9 p In GERMAN Presented at the Internationaler Kongress 'Umweltfreundlicher Verkehr durch moderne Verkehrstechnologien', Nuernberg, Fed. Republic of Germany, 24-25 Sep. 1990

(MBB-Z-0337-90-PUB; OTN-030880; ETN-91-99759) Avail: NTIS HC/MF A02

Environmental conditions taken into account during aircraft development where the emphasis is on the verification of technical possibilities and efficiency improvement are considered. It appears necessary to transfer, on a European scale, the technology and verification program for laminar wings, hydrogen aircraft and corresponding airport infrastructure. It is shown that a better blade geometry could reduce helicopter noise and that hydrogen propulsion will change aircraft configuration. ESA

N91-31135# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Airplane Div.

ENHANCED FIGHTER MANEUVERABILITY AIRCRAFT (X-31A) WING AND THRUST VECTORING VANE DESIGN

H. LONSINGER, G. GUENTHER, and J. SCHWEIGER Nov. 1990 12 p

(MBB-FE22/S/PUB/0433/A; ETN-91-99763) Copyright Avail: NTIS HC/MF A03

The X-31A experimental aircraft configured to explore the maneuverability and flying qualities in the high angle of attack and post stall regime using a digital fly by wire flight control system (FCS) and carbon carbon thrust vectoring vanes is described. Advanced NARMCO 5245/T800 chlorofluorocarbons (CFC) epoxy materials are used for the monolithic wing box covers and cored control surfaces whereas carbon carbon composite is used for the three high temperature affected thrust vectoring vanes. The wing is designed with an optimization program for minimum weight. Primary design parameters are buckling and strain limits, while a high flutter margin is required to reduce the effort for aeroelastic qualification programs. The structural development including the optimization process is described. General design criteria, material selection, material allowables, component design, and manufacturing principles are discussed. ESA

N91-31136# Office National d'Etudes et de Recherches Aeronautiques, Paris (France). Direction de la Physique Generale. **VORTEX-BLADE INTERACTION ON A HELICOPTER PRINCIPAL ROTOR. VALIDATION OF THE S2DI**

COMPUTATION PROGRAM AND STUDY OF VORTEX MODELS [BRUIT D'INTERACTION PALE-TOURBILLON SUR UN ROTOR PRINCIPAL D'HELICOPTERE. VALIDATION DU PROGRAMME DE CALCUL S2DI ET ETUDE DE MODELES DE TOURBILLON]

G. RAHIER Aug. 1990 31 p In FRENCH

(Contract DRET-89-34-001)

(ONERA-RT-92/5094-PY; ETN-91-99937) Avail: NTIS HC/MF A03

A 2-D singularities method of computing the pressures on a profile is tested for the case of steady flows, degrees of incidence, pitching oscillations and undulating flow. Results validate the computation code, which proves to be fast and reliable. Study of different vortex interaction models shows that in a 2-D computation it is necessary to have a vortex representation which allows for deformation in order to correctly predict the strong interactions and collisions. ESA

N91-31137# Association Aeronautique et Astronautique de France, Paris.

SECOND GENERATION SUPERSONIC TRANSPORT AIRCRAFT: LOW SPEED AERODYNAMICS [AVION DE TRANSPORT SUPERSONIQUE DE SECONDE GENERATION: AERODYNAMIQUE BASSES VITESSES]

P. CARLIER, C. PUJOL, and F. BEGIN 1989 43 p In FRENCH Presented at 26th Colloque d'Aerodynamique Appliquee,

Toulouse, France, 23-25 Oct. 1990

(AAAF-NT-89-02; ISBN-2-7170-0963-9; ISSN-0243-0177;

ETN-91-99943) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 30 francs

The ATSF (French acronym for future supersonic transport aircraft) program, to find better subsonic/supersonic performance compromises and to optimize the wing configuration for low speed, taking turbulent phenomena into account, is outlined. Aerodynamics of wings at low, medium and high angles of incidence, and the influence of sideslip are studied. Lateral and longitudinal turbulent coefficients are considered. The Concorde aircraft is specifically addressed. First wind tunnel flow visualization tests for the ATSF preproject are reported. ESA

N91-31140* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ROTATABLE NON-CIRCULAR FOREBODY FLOW CONTROLLER Patent

CARY A. MOSKOVITZ, inventor (to NASA) 24 Sep. 1991 11 p Filed 10 Aug. 1990

(NASA-CASE-LAR-14212-1-CU; US-PATENT-5,050,819;

US-PATENT-APPL-SN-565090; US-PATENT-CLASS-244-75R;

US-PATENT-CLASS-244-87; US-PATENT-CLASS-244-88;

US-PATENT-CLASS-244-199; US-PATENT-CLASS-244-120;

INT-PATENT-CLASS-B64C-19/00) Avail: US Patent and Trademark Office CSCL 01/3

The invention is a rotatable, non-circular forebody flow controller. The apparatus comprises a small geometric device located at a nose of a forebody of an aircraft and a non-circular cross-sectional area that extends toward the apex of the aircraft. The device is symmetrical about a reference plane and preferably attaches to an axle which in turn attaches to a rotating motor. The motor rotates the device about an axis of rotation. Preferably, a control unit connected to an aircraft flight control computer signals to the rotating motor the proper rotational positioning of the geometric device.

Official Gazette of the U.S. Patent and Trademark Office

N91-31141# Naval Air Development Center, Warminster, PA. Air Vehicle and Crew Systems Technology Dept.

EFFECT OF WIND OVER DECK CONDITIONS ON AIRCRAFT APPROACH SPEEDS FOR CARRIER LANDINGS Summary Report

RICHARD P. MICKLOS 1 Sep. 1991 36 p

(AD-A239511; NADC-91027-60) Avail: NTIS HC/MF A03

CSCL 01/2

Aircraft Approach Speeds measured during NADC photographic surveys of operational carrier landings have been higher than anticipated when compared to NATOPS recommended approach speed curves. The cause of this increase in approach speed is identified as the increase in the wind over deck, above minimum recovery head wind requirements, available during actual carrier landings. GRA

N91-32045# National Aerospace Lab., Tokyo (Japan).

AERODYNAMIC DESIGN OF NON-PLANAR WING BY INVERSE METHOD WITH NAVIER-STOKES EQUATION

TAKASHI KAIKEN, JUN OGINO (Mitsubishi Heavy-Industries Ltd., Tokyo, Japan), and SUSUMU TAKANASHI In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 103-107 Nov. 1990 In JAPANESE; ENGLISH summary Avail: NTIS HC/MF A14

For the design of non-planar wings, it is indispensable to use the Navier-Stokes code for the viscous effect of corner flow and the induced separation. Presented here is the design of a non-planar wing using an inverse method with a Navier-Stokes code instead of the usual full potential code. Author

N91-32046# National Aerospace Lab., Tokyo (Japan).

NAVIER-STOKES SIMULATION FOR COMPLETE AIRCRAFT CONFIGURATION

SUSUMU TAKANASHI and KEISUKE SAWADA (Kawasaki Heavy

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Industries Ltd., Kagamihara, Japan) *In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics* p 109-113 Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

Numerical simulation of transonic viscous flow using a block structured grid system is carried out for a complete aircraft configuration. The Navier-Stokes equations are numerically solved by the second order accurate finite volume method based on a Total Variation Diminishing (TVD) upward scheme. To achieve accuracy of convergence, a planar Gauss-Seidel relaxation method is adopted. A two equation eddy viscosity model is used for turbulent flow computations. Author

N91-32047# Fuji Heavy Industries Ltd., Utsunomiya (Japan).
BLENDED WING-BODY CONFIGURATION DESIGN USING TRANSONIC INVERSE CODE

YOSUHIRO TANI, YASUHIRO KOSHIOKA, and HIDEHIRO HIROSE *In National Aerospace Lab., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics* p 115-120 Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

An iterative procedure is described for a three dimensional wing-body configuration using a three dimensional transonic inverse method with target pressure distribution. In this application, it is combined with a full potential analysis code. Some of the design results for a conventional and a blended wing-body configuration are presented. Also, a finite volume Euler solver is applied to analyze the designed configurations. Author

N91-32130# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ON THE MAXIMUM RANGE OF FLYING WINGS Final Report
PETER J. TORVIK 1 Sep. 1990 21 p
(AD-A229487; AFIT/EN-TR-90-07) Avail: NTIS HC/MF A03
CSCL 01/3

The classical equations for determining the maximum range of aircraft with propeller and jet propulsion systems are reviewed, along with previous work conducted to determine the optimal division of aircraft volume between fuselage and wing components. That the jet powered flying wing configuration produces optimal range only for limited geometries is confirmed. The optimal range of aircraft employing high bypass jet engines is explored, and found to lead to a broader range of design parameters for which the flying wing design produces maximum range than is the case when a pure jet system is used. GRA

N91-32131# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Abt. Triebwerkssysteme.
FLIGHT MECHANICAL MODEL FOR PERFORMANCE CALCULATIONS AND INTERACTIONS BETWEEN FLIGHT VEHICLE AND RAMJET IN REGARD TO THE FLIGHT ORBIT
FRANS G. J. KREMER Feb. 1991 95 p In GERMAN; ENGLISH summary Report will also be announced as translation ESA-TT-1267
(DLR-FB-91-03; ISSN-0939-2963; ETN-91-90039; ESA-TT-1267)
Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB PL DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 35.50 DM

Performance calculations for a ramjet first require determination of the thrust at each point of the flight orbit. This is done by means of a flight mechanical model. The flight mechanical model builds on the law of equilibrium of forces. Furthermore an aerodynamic model for the flight vehicle is used. The flight orbit is calculated given the flight profile, acceleration in flight direction and curving acceleration. The interactions between the flight vehicle and the ramjet in close regard to the flight orbit are addressed. The parameters which influence the fuel consumption in regard to mission aspects are described. The role of the angle of attack and the significance of the design are closely examined. The interactions are described by means of variation of parameters (being the dynamic head, acceleration in flight direction and the curving acceleration). ESA

N91-32132*# Boeing Co., Seattle, WA.
AN EXAMPLE OF REQUIREMENTS FOR ADVANCED SUBSONIC CIVIL TRANSPORT (ASCT) FLIGHT CONTROL SYSTEM USING STRUCTURED TECHNIQUES Interim Report
ROBERT E. MCLEES and GERALD C. COHEN Oct. 1991 273 p
(Contract NAS1-18586)
(NASA-CR-187526; NAS 1.26:187526) Avail: NTIS HC/MF A12
CSCL 01/3

The requirements are presented for an Advanced Subsonic Civil Transport (ASCT) flight control system generated using structured techniques. The requirements definition starts from initially performing a mission analysis to identify the high level control system requirements and functions necessary to satisfy the mission flight. The result of the study is an example set of control system requirements partially represented using a derivative of Yourdon's structured techniques. Also provided is a research focus for studying structured design methodologies and in particular design-for-validation philosophies. Author

N91-32133# National Center for Atmospheric Research, Boulder, CO. Atmospheric Technology Div.
UNCERTAINTY ANALYSIS OF A RADOME FLUSH ORIFICE AIR MOTION SYSTEM FOR THE MEASUREMENT OF AIRCRAFT INCIDENT ANGLES
EDWARD N. BROWN Mar. 1991 35 p
(PB91-198176; NCAR/TN-359+STR) Avail: NTIS HC/MF A03
CSCL 01/3

An assessment of the uncertainties, or maximum expected error, in the measurement of the relative wind angles is patterned after the published works including Abernethy (1973) and the International Standards Organization (1978). Separate appendices detail the analysis and elemental errors of aircraft static and dynamic pressures, the radome sensitivity coefficients, the differential pressures corresponding to the wind angles, the wind angles, and true airspeed. The results enable: (1) calculation of the accuracy of parameters to be derived from the uncertainties; and (2) some control over the sources of error to achieve a required level of accuracy. The analysis deals with the subsonic speed range and is limited to incident angle range of +/- 10 degrees. GRA

N91-32134*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AEROELASTIC LOADS AND STABILITY INVESTIGATION OF A FULL-SCALE HINGELESS ROTOR
RANDALL L. PETERSON and WAYNE JOHNSON (Johnson Aeronautics, Palo Alto, CA.) Jul. 1991 11 p Presented at DGLR/AAAF/AIAA/RAeS International Forum on Aeroelasticity and Structural Dynamics, Aachen, Fed. Republic of Germany, 3-6 Jun. 1991
(NASA-TM-103867; A-91157; NAS 1.15:103867) Avail: NTIS HC/MF A03 CSCL 01/3

An analytical investigation was conducted to study the influence of various parameters on predicting the aeroelastic loads and stability of a full-scale hingeless rotor in hover and forward flight. The CAMRAD/JA (Comprehensive Analytical Model of Rotorcraft Aerodynamics and Dynamics, Johnson Aeronautics) analysis code is used to obtain the analytical predictions. Data are presented for rotor blade bending and torsional moments as well as inplane damping data obtained for rotor operation in hover at a constant rotor rotational speed of 425 rpm and thrust coefficients between 0.0 and 0.12. Experimental data are presented from a test in the wind tunnel. Validation of the rotor system structural model with experimental rotor blade loads data shows excellent correlation with analytical results. Using this analysis, the influence of different aerodynamic inflow models, the number of generalized blade and body degrees of freedom, and the control-system stiffness at predicted stability levels are shown. Forward flight predictions of the BO-105 rotor system for 1-G thrust conditions at advance ratios of 0.0 to 0.35 are presented. The influence of different aerodynamic inflow models, dynamic inflow models and shaft angle

variations on predicted stability levels are shown as a function of advance ratio. Author

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AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A91-54567

INTEGRATED MODULAR AVIONICS FOR NEXT GENERATION COMMERCIAL AIRPLANES

MICHAEL J. MORGAN (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, Aug. 1991, p. 9-12. refs Copyright

The goals and objectives of integrated modular avionics (IMA) are discussed. One candidate computing architecture for IMA, the Boeing 777 Airplane Information Management System (AIMS), is presented. The cabinet architecture, fault tolerance characteristics, backplane bus, and functional growth provisions are considered. The integration concepts being developed for AIMS represent a first step in real-world application of the IMA technologies. I.E.

A91-54568

A GROUND AND OBSTACLE COLLISION AVOIDANCE TECHNIQUE (GOCAT)

C. HEWITT, A. J. HICKEY, and J. D. BOYES (GEC Avionics, Ltd., Rochester, England) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, Aug. 1991, p. 13-20. Copyright

The need to provide aircrew with a timely warning of a dangerously close approach to the terrain is discussed, along with the benefits this capability is expected to provide and specific requirements that it must fulfill. The ground proximity warning techniques that are currently available are reviewed, and their benefits and limitations are assessed. The GEC Avionics Ground and Obstacle Collision Avoidance Technique (GOCAT) is described. The particular advantages of the GOCAT approach are identified. Because GOCAT uses a database of the terrain and obstacles around the aircraft it has a very low nuisance alarm rate but will always generate a warning when the aircraft is in a dangerous situation. Issues of parameter selection, search area definition and system limitations are examined. The results of a GOCAT simulation are presented. The system performance parameters are discussed, and database requirements are reviewed. The characteristics of a practical implementation for both civil and military applications are briefly stated. I.E.

A91-54576*

IEEE/AIAA/NASA DIGITAL AVIONICS SYSTEMS CONFERENCE, 9TH, VIRGINIA BEACH, VA, OCT. 15-18, 1990, PROCEEDINGS

New York, Institute of Electrical and Electronics Engineers, Inc., 1990, 717 p. For individual items see A91-54577 to A91-54681. Copyright

The present conference on digital avionics discusses vehicle-management systems, spacecraft avionics, special vehicle avionics, communication/navigation/identification systems, software qualification and quality assurance, launch-vehicle avionics, Ada applications, sensor and signal processing, general aviation avionics, automated software development, design-for-testability techniques, and avionics-software engineering. Also discussed are optical technology and systems, modular avionics, fault-tolerant avionics, commercial avionics, space systems, data buses, crew-station technology, embedded processors and operating systems, AI and expert systems, data links, and pilot/vehicle interfaces. O.C.

A91-54578

A FAULT TOLERANT FLY BY WIRE SYSTEM FOR MAINTENANCE FREE APPLICATIONS

R. W. DENNIS and A. D. HILLS (GEC Avionics, Ltd., Rochester, England) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 11-20. Research supported by Boeing Commercial Airplanes. refs Copyright

The authors describe a triplex primary flight computer system based on a reconfigurable architecture with extensive use of application specific ICs. The system comprises fault-tolerant FBW computers which are triplex dissimilar in both software and hardware. These command actuator control electronics (ACE) units via DATAC (ARINC 629) data buses. The authors review the architectural design issues in terms of integrity requirements and fault tolerance, leading to a design which not only meets civil safety requirements but also has ultra-high-reliability, offering little or no maintenance action. The FBW computer architecture is based on dividing the basic path into three subfunctional elements. Each of these elements is then replicated to provide fault tolerance. The internal element redundancy management function is performed both in hardware and software, and it is able to detect and isolate faulty elements and perform the necessary reconfiguration. The current expectation for system reliability gives an expected time to 95 percent probability of dispatch of 38,100 operating hours and has a predicted MTBMA of 92,700 operating hours per shipset. I.E.

A91-54583

HELICOPTER AND AVIONICS SYSTEMS ELECTROMAGNETIC ENVIRONMENTAL EFFECTS

DAVID P. MILLARD (Georgia Institute of Technology, Atlanta) and THOMAS A. TORRES IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 47-52. refs (Contract F09603-85-G-3104; F09603-89-G-0077) Copyright

It is shown that adverse electromagnetic environmental effects (E3) can be reduced during the configuration of military helicopters by implementing a complete helicopter E3 program. The E3 program methodology includes: (1) defining the electromagnetic environment (EME) in which the helicopter must operate and survive during all phases of its mission; (2) analyzing the performance of the helicopters avionics systems in the EME and correcting deficiencies in both Group A (interface) and Group B (boxes) systems; (3) testing the electromagnetic vulnerability of the helicopter in the EME; and (4) documenting the entire E3 engineering effort through an electromagnetic compatibility advisory board. The avionics configuration analysis program, a computer-aided engineering tool to accomplish the E3 analysis, and the ribbonized organized integrated wiring concept are presented. I.E.

A91-54585

DESIGN AND IMPLEMENTATION OF TERNARY EXOATMOSPHERIC AUTOPILOT SYSTEM

LEE-JU CHOI and JOHN M. BAILEY (Tennessee, University, Knoxville) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 58-63. refs Copyright

A ternary-microprocessor-based exoatmospheric autopilot system including a ternary valve servo system is designed in which the ternary processor and ternary hardware cover all navigational calculations and preprogrammed missions. The exoatmospheric autopilot system was designed completely with the symmetrical ternary (-1, 0, and +1) logic scheme. This system gives effective torque combinations into the reaction jet servo system. The functional operations of this ternary autopilot system are shown

06 AIRCRAFT INSTRUMENTATION

to be better than those of a binary-processor-based autopilot system. This ternary autopilot system can be reduced to few small blocks using CMOS circuits and VLSI techniques for an effective vehicle system. I.E.

A91-54587

AVIONICS SYSTEM INTEGRATION FOR THE MH-53J HELICOPTER

STEPHEN C. FELTER, DOUGLAS P. HILL, and CAREY A. SMITH (IBM Corp., Federal Sector Div., Owego, NY) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 70-75. refs

Copyright

The functions developed for the MH-53J helicopter are described, following a brief introduction of the Pave Low III system. In addition, other functions typically found in mission computers, but not in the MH-53J, are discussed. Future concepts for mission computer application are discussed. It is pointed out that the mission computer of a typical airborne platform transforms a group of independent avionic equipment into an integrated system. A centralized display system provides a common operator interface for all equipment, easing operation of the system and decluttering the instrument panel. Customized functions may be installed as required for a particular aircraft, allowing standardization of the other avionic equipment. As research progresses, the capabilities provided by the mission computer will continue to ease pilot workload and enhance the effectiveness of the avionic suite. I.E.

A91-54593

AUTOMATIC ALERT CODE AND TEST GENERATION SYSTEM

STEVE TAYLOR and JACK JANELLE (Honeywell, Inc., Air Transport Systems Div., Phoenix, AZ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 101-106.

Copyright

The MD-11 aircraft alerting function (AAF) software system was developed with the customer as the aircraft systems expert and the avionics supplier responsible for designing, implementing, testing and maintaining the software. Due to the complexity of the MD-11, frequent changes in alert logic were anticipated, forming a volatile development environment. In spite of these obstacles, a cost-effective method for developing the AAF software was devised and implemented. The authors address the following topics: how the MD-11 AAF operates; how the MD-11 AAF provides a cost-effective and timely method of allowing the customer to design each alert, make flight test changes, and maintain the alert data base; and how the MD-11 AAF allows the avionics supplier to easily verify and validate the alert logic using automatically generated test cases. I.E.

A91-54623

MODULAR AVIONICS SYSTEM ARCHITECTURE (MASA) - THE IMPACT OF FAULT TOLERANCE

LARRY D. BROCK and ANDREI L. SCHOR (Charles Stark Draper Laboratory, Inc., Cambridge, MA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 310-315. refs

(Contract F04606-87-D-0051)

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The Air Force Modular Avionics System Architecture (MASA) program is defining how the advantages of modular avionics can be applied to upgrades of current aircraft. Life cycle cost (LCC) studies performed for the MASA program showed significant savings when a modular architecture was used to integrate at least two or three avionics functions. These studies also showed no significant LCC penalty for the modular implementation of a single function. Other advantages not quantified in the LCC analysis include increased competition, reduced time lag for technology

insertion, and more effective implementation of integrated systems and fault tolerance. Some of the more interesting results were for fault-tolerant modular systems which could provide a high probability of full operational capability for a 30-day combat surge with no line maintenance. I.E.

A91-54636

NEW INSIGHT INTO UNDERSTANDING THE SUSCEPTIBILITY OF DIGITAL AVIONICS TO HIGH ENERGY RF (HERF)

GERRY FULLER (C.K. Consultants, Inc., Mariposa, CA) and DARRYL SORENSEN IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 386-391. refs

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Recent insight gained through a decade of military programs has led to the understanding of the susceptibility of avionics to the high-energy radio frequency (HERF) threat. It is now possible to calculate the penetration of electromagnetic energy into sensitive electronic circuits, to design protective means into these circuits, and to verify the design protection through analysis and low-level tests followed by a limited number of high-level verification tests. It is suggested that what is needed is to make available to the aircraft industry the following: a comprehensive susceptibility assessment methodology; an assessment tool set; an increased awareness of RF susceptibility of electronic/electrical systems and methods of protection; and a comprehensive application methodology for HERF protection for commercial aircraft and their avionics based on the tools, techniques, and experience developed for the DOD. It is further recommended that the transfer of the DOD HERF technology directly to industry for its use and, where necessary, as a service for assessing, correcting, and demonstrating compliance of these systems is needed. I.E.

A91-54638

EFFECT OF IMPEDANCE CONTROL ON THE RESPONSE OF AIRCRAFT DIGITAL SUBSYSTEMS TO HIRF

K. P. SLATTERY and G. FULLER (C.K. Consultants, Inc., Mariposa, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 401-403. Research supported by C.K. Consultants, Inc.

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Research into the effect that complex source and load impedances can have on the predicted radiated susceptibility for digital avionics systems as a function of frequency is described. Understanding the effect that these impedances can have on the upset levels in circuit boards employing these logic families can aid the designer early in the design cycle to minimize random and potentially dangerous circuit responses. Analytical models describing the effects of incident EM fields on cables over ground planes have been developed. The development grew out of a need to understand HIRF-type phenomena inside the fuselage of aircraft. High-incidence EM fields can generate significant induced fields on the aircraft cables. These fields can in turn develop large voltages at the inputs to avionics circuits. These levels can and do approach the upset thresholds of the systems. It is noted that if one were to consider only how the wiring and cabling were to respond to incident EM fields when terminated solely in pure resistances the designer would be faced with a possible 30-dB discrepancy between predicted and actual response. Therefore, knowing the frequency dependency of the impedances attached to the ends of aircraft cabling is of utmost importance. I.E.

A91-54645

AN INTERACTIVE GRAPHICS EDITOR FOR COMPUTER-GENERATED COCKPIT DISPLAYS

R. J. MONTOYA, TIMOTHY L. TURNER, RAMASUBRAMANIAN SURESH (Research Triangle Institute, Research Triangle Park, NC), and DERRYL A. WILLIAMS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York,

Institute of Electrical and Electronics Engineers, Inc., 1990, p. 441-446. refs
Copyright

The interactive graphics editor, an experimental, PHIGS-based display editor, is described. Written in C and running in a MicroVAX II/Adage 3000 display system, the interactive graphics editor is intended to support the rapid prototyping of 2D/3D cockpit display formats, the preview of their animation, and the automatic generation of the software that animates them in real time. Certain innovations which have resulted from this research work are described, and the development of a typical cockpit display format is described. Recommendations for future enhancements and applications of this tool are given. I.E.

A91-54646* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DETERMINATION OF WASHOUT PERFORMANCE OF VARIOUS MONOCHROME DISPLAYS UNDER SIMULATED FLIGHT AMBIENT AND SOLAR LIGHTING CONDITIONS

VERNON M. BATSON, JAMES B. ROBERTSON, and RUSSELL V. PARRISH (NASA, Langley Research Center, Hampton, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 447-452. refs

The aircraft cockpit ambient lighting simulation system (ACALSS) has been developed to study display readability and associated pilot/vehicle performance effects in a part-task simulator cockpit. In the study reported here, the ACALSS was used to determine the illumination levels at which subjects lose the ability to maintain aircraft states when using three display technologies as display media for primary flight displays: a standard monochrome EL (electroluminescent) flat-panel, a laboratory-class monochrome CRT, and an enhanced-brightness EL flat-panel. The multivariate statistical technique of modified profile analysis was used to test for performance differences between display devices as functions of illumination levels. The standard monochrome EL flat-panel display began to washout after the 2500 foot-candle level of illumination. The monochrome CRT began to washout after the 5500 foot-candle level of illumination. No performance decrements by increased illumination up to the 12,000 foot-candle level were found for the enhanced-brightness EL flat-panel display. What was not anticipated was that half the subjects would subjectively prefer the CRT over the enhanced-brightness EL, even though their performance errors would have indicated the opposite. I.E.

A91-54649
A MILITARY AVIONICS 32-BIT ADVANCED MODULAR PROCESSOR SYSTEM

DARWIN R. WITZEL (Control Data Corp., Minneapolis, MN) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 462-467. refs

Copyright

A high-performance processor architecture embedded in a modular computer system with advanced application software real-time operating system support is discussed. The objective is to provide a powerful processing environment to satisfy the computational demands of data fusion and other expansion potentials of the avionics mission function. The processor engine of this system is the AMP (advanced modular processor), an extremely powerful 32-b embedded 20 MIPS processor deriving its performance from the MIPS R3000/R3010 RISC chip set. The distributed system architecture integrates multiple processors, a flexible I/O subsystem, and fault-tolerant features. A dual-redundant VME-like backplane and reconfiguration through reassignment of hot spare processors greatly increases reliability and availability. Consideration is given to the hardware system architecture, the external interfaces, the semiconductor technology, the real-time operating system, and the application software development. I.E.

A91-54659

INTEGRATION OF TERRAIN ELEVATION AND FEATURE DATA FOR TOMORROW'S COCKPITS

RONALD YOUNG (Hughes Aircraft Co., Radar Systems Group, El Segundo, CA) and JEFF SIFERD (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 525-528.

Copyright

To date, the major use of digital terrain and feature data has been for radar prediction, intervisibility calculations, and in some cases, a replacement for conventional paper charts. It is noted that, as additional and more accurate spatial (digital) data products become available, and new digital utilization technologies are developed, new weapon systems will become increasingly dependent on these spatial products. Spatial (digital) data products are defined as a combination of old (archival), recent, and/or real-time data. These products will improve mission performance in the areas of mission planning and optimum route selection; threat and terrain detection and obstacle avoidance; autonomous navigation; dynamic route planning; and situation awareness. Further, these digital data products will be included as an integral part of specific weapon systems. Using the Integrated Terrain Access and Retrieval System (ITARS) as a prototype for a future information management system, some of the current efforts at integrating these data into the cockpit are described. The integration effort is using the integrated test bed at the USAF Wright Aeronautical Laboratories and the ITARS developed for the Air Force and Navy. Current and future activities are described. I.E.

A91-54660* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

RECENT RESEARCH RESULTS IN STEREO 3-D PICTORIAL DISPLAYS AT LANGLEY RESEARCH CENTER

RUSSELL V. PARRISH, ANTHONY M. BUSQUETS, and STEVEN P. WILLIAMS (NASA, Langley Research Center, Hampton, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 529-539. refs

Recent results from a NASA-Langley program which addressed stereo 3D pictorial displays from a comprehensive standpoint are reviewed. The program dealt with human factors issues and display technology aspects, as well as flight display applications. The human factors findings include addressing a fundamental issue challenging the application of stereoscopic displays in head-down flight applications, with the determination that stereoacuity is unaffected by the short-term use of stereo 3D displays. While stereoacuity has been a traditional measurement of depth perception abilities, it is a measure of relative depth, rather than actual depth (absolute depth). Therefore, depth perception effects based on size and distance judgments and long-term stereo exposure remain issues to be investigated. The applications of stereo 3D to pictorial flight displays within the program have repeatedly demonstrated increases in pilot situational awareness and task performance improvements. Moreover, these improvements have been obtained within the constraints of the limited viewing volume available with conventional stereo displays. A number of stereo 3D pictorial display applications are described, including recovery from flight-path offset, helicopter hover, and emulated helmet-mounted display. I.E.

A91-54661

AN ALTERNATIVE APPROACH TO PROVIDING EXTERNAL VISION TO PILOTS OF FUTURE AIR VEHICLES

MARK S. ROLWES (McDonnell Aircraft Co., Saint Louis, MO) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 540-544.

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06 AIRCRAFT INSTRUMENTATION

An electronic visibility system concept that has potential as an alternative to transparent canopies or wraparound windows for satisfying the needs of next-generation aircraft pilots for out-of-cockpit vision is described. In a joint MDC/NASA flight test program, four test pilots evaluated a proof-of-concept system in order to compare natural and electronic visibility landing performance, focus future system design work on critical design issues, and establish concept feasibility. Data collected during the flight tests show that landing performance when using the electronic vision was nearly identical to natural visibility landings. More importantly, the pilots were unanimous in their opinion that the system concept is feasible, offers numerous advantages, and should be pursued further. I.E.

A91-54669

AN ADA-BASED, PORTABLE DESIGN WORKSTATION FOR COMPUTER-GENERATED COCKPIT DISPLAYS

TIMOTHY L. TURNER, M. C. BARKER, RAMASUBRAMANIAN SURESH, JAMES V. AANSTOOS, DONNA M. JEWELL, R. J. MONTOYA (Research Triangle Institute, Research Triangle Park, NC), and DERRYL A. WILLIAMS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 582-588. refs

Copyright

The Airborne Graphics Software Support System (AGSSS), an Ada/PHIGS-based design workstation for the rapid prototyping and development of cockpit displays and their enabling software for airborne display systems, is described. The AGSSS supports the interactive and artistic creation of cockpit display formats, interactive specification of the dynamics of the display, symbology, and the incremental testing of the emerging display. AGSSS uses the resultant object definitions (in PHIGS) and display actions specifications (in Ada) to automatically generate properly partitioned display system code (in Ada and Ada/PHIGS) for a target display system. I.E.

A91-54676

MODULAR AVIONICS RETROFIT APPLICATIONS

ELLIS F. HITT (Battelle Columbus Laboratories, OH), WAYNE BATES, and SAEED EMADI (USAF, Hill AFB, UT) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 645-650. refs

(Contract F04606-89-D-0034)

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Cost-benefit data on the use of common hardware and software modules across multiple weapon systems are presented. The F-111, F-15, F-16, KC-135, and E-3 aircraft are analyzed, and subsystems which are high-maintenance items that can be replaced by common modules (hardware and software) and used in all of these aircraft types are identified. It is shown that the development and retrofit of common hardware and software modules in these aircraft types for the functions analyzed will result in a savings of \$2-5 billion (depending upon the number of aircraft retrofits, the starting date of the program and the actual program management concept paralleling that suggested in this study). The Air Force Logistic Command maintains far more aircraft than would be produced during any new aircraft development and production system. It is suggested that program decisions should be based on the total life cycle cost of maintaining the existing aircraft. Today's maintenance costs can be substantially reduced by inserting new technology systems designed to be highly reliable and fault tolerant, and to require minimum maintenance, as suggested. I.E.

A91-54678

DIGITAL MAP INTEGRATION IN ADVANCED TACTICAL COCKPITS

RANDOLPH G. FARMER (Northrop Corp., Aircraft Div., Hawthorne,

CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 657-662. refs

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A research project to define requirements for integrating a digital map in advanced cockpits for the year 2000 and beyond. The issues being addressed in this project include map size and scale requirements, display sizing and compatibility, map data storage requirements, embedded compression processors, databus traffic, processor workload, and map utility. During 1990, work has progressed in (1) defining operational requirements, (2) identifying the storage/image-quality/display size tradeoffs, and (3) developing a technique for enhancing the pilot vehicle interface. I.E.

A91-55744* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEVELOPMENTS IN FLOW VISUALIZATION METHODS FOR FLIGHT RESEARCH

BRUCE J. HOLMES, CLIFFORD J. OBARA, GREGORY S. MANUEL, and CYNTHIA C. LEE (NASA, Langley Research Center, Hampton, VA) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 590-596. refs

Copyright

With the introduction of modern airplanes utilizing laminar flow, flow visualization has become an important diagnostic tool in determining aerodynamic characteristics such as surface flow direction and boundary-layer state. A refinement of the sublimating chemical technique has been developed to define both the boundary-layer transition location and the transition mode. In response to the need for flow visualization at subsonic and transonic speeds and altitudes above 20,000 feet, the liquid crystal technique has been developed. A third flow visualization technique that has been used is infrared imaging, which offers non-intrusive testing over a wide range of test conditions. A review of these flow visualization methods and recent flight results is presented for a variety of modern aircraft and flight conditions. Author

A91-55746* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

VAPOR-SCREEN TECHNIQUE APPLIED TO A DELTA-WING AIRCRAFT

JOHN E. LAMAR (NASA, Langley Research Center, Hampton, VA) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 603-609. refs

Copyright

Recently, the vapor-screen technique has been applied to a delta-wing aircraft (F-106B) during both subsonic 1-g and transonic high-g flights. Selected subsonic vapor-screen images are presented which show the benefits of digital enhancement. Among the major findings are that multiple, corotating vortices exist up to 20-deg angle of attack, and the measured flight core location is not well predicted by theory. Planned extensions for this work are also discussed. Author

A91-56351

THE ROLES OF PILOT AND AIR TRAFFIC CONTROLLER IN FUTURE AIR TRANSPORT SYSTEMS [DIE ROLLE VON PILOT UND LOTSE IM ZUKUNFTIGEN LUFTVERKEHRSSYSTEM]

RALF BEYER (DLR, Institut fuer Flugfuehrung, Brunswick, Federal Republic of Germany) DLR-Nachrichten (ISSN 0937-0420), Aug. 1991, p. 2-5. In German.

Copyright

Future demands on air transport systems regarding capacity and environmental protection are examined. The changing roles of pilot and air traffic controllers that will help meet those demands are addressed. Emphasis is given to the applications of automation in these areas. C.D.

A91-56474

AIRBORNE COMPUTER TECHNOLOGY INITIATIVES

MICHAEL R. KELLEY (Honeywell, Ltd., Sperry Commercial Flight Systems Group, Tullamarine, Australia) IN: Radio Technical Commission for Aeronautics, Annual Assembly and Technical Symposium, Washington, DC, Dec. 3-5, 1990, Proceedings. Washington, DC, Radio Technical Commission for Aeronautics, 1990, p. 143-152.

Copyright

Current directions in computer technological development are discussed with specific reference to the 'total system' concept of integrated air-transport communications. Processing technology is reviewed with emphasis given to microprocessor performance and memory-chip density, and applications for increasing computing capacity include enhanced 4D navigation systems. Airborne computer architectures are described in detail, and the Integrated Modular Avionics (IMA) environment is introduced. The IMA concept encompasses resource sharing, fault-tolerant implementation, and monitoring by means of Line Replaceable Modules which can adapt to specific needs. Airborne mass-memory systems are needed to complement digital data links, and the importance of standardization in all computing areas is underscored. C.C.S.

N91-31143*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FLIGHT TESTS WITH A DATA LINK USED FOR AIR TRAFFIC CONTROL INFORMATION EXCHANGE

CHARLES E. KNOX and CHARLES H. SCANLON Sep. 1991 38 p

(NASA-TP-3135; L-16936; NAS 1.60:3135) Avail: NTIS HC/MF A03 CSCL 17/2

Previous studies showed that air traffic control (ATC) message exchange with a data link offers the potential benefits of increased airspace system safety and efficiency. To accomplish these benefits, data link can be used to reduce communication errors and relieve overloaded ATC voice radio frequencies, which hamper efficient message exchange during peak traffic periods. Flight tests with commercial airline pilots as test subjects were conducted in the NASA Transport Systems Research Vehicle Boeing 737 airplane to contrast flight operations that used current voice communications with flight operations that used data link to transmit both strategic and tactical ATC clearances during a typical commercial airlift from takeoff to landing. The results of these tests that used data link as the primary communication source with ATC showed flight crew acceptance, a perceived reduction in crew work load, and a reduction in crew communication errors.

Author

N91-32135*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

HUMAN-CENTERED AIRCRAFT AUTOMATION: A CONCEPT AND GUIDELINES

CHARLES E. BILLINGS Aug. 1991 119 p

(NASA-TM-103885; A-91192; NAS 1.15:103885) Avail: NTIS HC/MF A06 CSCL 01/4

Aircraft automation is examined and its effects on flight crews. Generic guidelines are proposed for the design and use of automation in transport aircraft, in the hope of stimulating increased and more effective dialogue among designers of automated cockpits, purchasers of automated aircraft, and the pilots who must fly those aircraft in line operations. The goal is to explore the means whereby automation may be a maximally effective tool or resource for pilots without compromising human authority and with an increase in system safety. After definition of the domain of the aircraft pilot and brief discussion of the history of aircraft automation, a concept of human centered automation is presented and discussed. Automated devices are categorized as a control automation, information automation, and management automation. The environment and context of aircraft automation are then considered, followed by thoughts on the likely future of automation of that category. Author

AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A91-53579

BATTERY STANDARDIZATION

WILLIAM JOHNSON, VAIDEVUTIS ALMINAUSKAS, and ALAN GOODMAN (U.S. Navy, Naval Weapon Support Center, Crane, IN) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 9 p.

(SAE PAPER 911159) Copyright

Navy aircraft battery standardization is considered. It is concluded that battery standardization, which has replaced many different types of high-cost small quantity batteries with a few large-volume low-cost batteries, resulted in major improvements in battery performance, reliability, and costs. The replacement of high maintenance batteries such as nickel-cadmium with the new low-maintenance sealed lead-acid technology has cut the maintenance by as much as 93 percent. O.G.

A91-53581

LIFE OF THE AIRFRAME MAINTENANCE FREE BATTERY

RICHARD FLAKE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 8 p. refs

(SAE PAPER 911161) Copyright

A program aimed at increasing the performance and reliability of aircraft batteries is described with particular attention given to the performance of the sealed lead-acid batteries and the sealed Ni-Cd maintenance free batteries. Sealed battery systems are based on intelligent charges capable of built-in-testing, fault indication, and warranty tracking. O.G.

A91-53589

PROPULSION SYSTEMS WITH AIR PRECOOLING FOR AEROSPACEPLANE

A. S. RUDAKOV and V. V. BALEPIN (Tsentr'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 8 p. refs

(SAE PAPER 911182) Copyright

Using LH2 heat sink capacity for air precooling in turbojets allows to increase specific impulse and in many cases to reduce specific mass (mass-to-sea level thrust ratio). A number of precooled turbojet schemes are considered. Classification of turbojet according to the cooled air amount and depth of cooling is proposed. ATR with extended precooling (T_{out} = 100 K) is examined in more detail. For propulsion systems including different types of engines running simultaneously, the concept of LH2 heat sink capacity concentration for turbojet air precooling is proposed. Author

A91-53813#

A JOINT PROPULSION PERSPECTIVE OF THE NEXT GENERATION SUPERSONIC TRANSPORT

S. C. GILKEY (GE Aircraft Engines, Cincinnati, OH) and R. W. HINES (United Technologies Corp., Pratt and Whitney Group, East Hartford, CT) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 962-968. refs

(AIAA PAPER 91-3330) Copyright

A review of continuing research in developing a second generation SST propulsion system is presented. Attention is given to the major environmental issues of airport noise, engine emissions, and sonic boom. Various engine and exhaust nozzle concepts are examined to validate the emissions and acoustics technologies required for this aircraft. R.E.P.

07 AIRCRAFT PROPULSION AND POWER

A91-54044*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AN EFFICIENT TIP JET DRIVE

JAMES D. PHILLIPS (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 28 p. refs

(AIAA PAPER 91-3124) Copyright

A reexamination is conducted of the ideal propulsive efficiency of helicopter main rotor tipjet drives, in view of reduced tip-speed and lower jet exhaust velocity possibilities afforded by more advanced rotor designs than those contemplated in the 1950s. Relative to a hot jet-drive design, the most efficient system presently formulated improves ideal propulsive efficiency by 62 percent, actual propulsive efficiency by 45 percent, and overall fuel efficiency by 19 percent. This vehicle, with reduced rotor speed and increased rotor solidity, will result in a lighter, quieter vehicle than a turboshaft rotor-drive system, up to a gross vehicle weight of 36,400 lbs. O.C.

A91-54050#

POWERPLANTS FOR VERY HIGH CAPACITY COMMERCIAL TRANSPORTS

P. M. SAGDEO (Western Michigan University, Kalamazoo, MI) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 11 p. refs (AIAA PAPER 91-3131) Copyright

The paper presents results of a parametric study of the thermodynamic cycle design for very high bypass ratio turbofan engines for very high capacity commercial transports. Aircraft with take-off weights of the order of 2 million pounds will require a large number of 50,000-60,000 lb class engines or 3 or 4 very large engines producing about 100,000 lb of static thrust. Current inventory of aircraft engines could provide a good choice of powerplants if the number is not limited to 3 or 4. However, a smaller number of engines optimized for a specific mission requirement with a higher bypass ratio than the current engines may be a better way of obtaining a better overall efficiency of the engine. The parameters studied here include possible range of turbine inlet temperatures, component efficiencies, and compressor pressure ratios. The results show that there is a practical limit to the bypass ratio and a very substantial increase over the current values can be obtained only at the expense of very high turbine inlet temperature. Author

A91-54051*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF TURBINE BYPASS AND MIXED FLOW

TURBOFAN ENGINES FOR A HIGH-SPEED CIVIL TRANSPORT
JONATHAN A. SEIDEL, WILLIAM J. HALLER, and JEFFREY J. BERTON (NASA, Lewis Research Center, Cleveland, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 17 p. refs (AIAA PAPER 91-3132) Copyright

A comparison of the turbine bypass engine and the mixed flow turbofan for a Mach 2.4 cruise application is presented. A parametric assessment is conducted for each cycle. Parameters that are investigated for the turbine bypass engine include design bypass, combustor exit temperature, and overall pressure ratio. Parameters that are investigated for the mixed flow turbofan include fan pressure ratio, mixer design pressure ratio, and combustor exit temperature. The engines are analyzed for a 5000-nautical-mile, all supersonic cruise mission to determine the aircraft takeoff gross weights. The effects of takeoff noise, cruise emissions, the addition of subsonic cruise legs, and constrained supersonic cruise altitudes are also evaluated. P.D.

A91-54052#

CONCEPTUAL STUDY OF SUPERSONIC PROPULSION SYSTEMS

TOSHIKI INOUE, JUN-ICHI HIROKAWA (Ishikawajima-Harima Heavy Industries Co., Ltd., Tokyo, Japan), TOSHIO HANAI, and HIKARU TAKAMI (Mitsubishi Heavy Industries, Ltd., Tokyo,

Japan) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p. refs (AIAA PAPER 91-3133) Copyright

A comparative study is conducted of two variable-cycle engine concepts applicable to next-generation SSTs: a 'single-bypass' engine (SBE), and a 'tandem-fan' engine (TFE). This evaluation gives attention to engine-choice effects on aircraft takeoff gross weight, and notes that the impact increases with rising cruise speed. While the TFE is superior to the SBE at Mach 2.0, the SBE is potentially superior at Mach 2.5. The weight of such noise-suppression components as the TFE's fan mode operation-change system is judged to be a critical consideration. O.C.

A91-54053#

AIRCRAFT PERFORMANCE SENSITIVITIES TO EJECTOR NOZZLE CONCEPTS

GUSTAVO G. ORDONEZ and MARTIN J. GEORGES (Northrop Corp., Aircraft Div. Hawthorne, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. Research supported by Northrop Corp. refs (AIAA PAPER 91-3135) Copyright

Advanced aircraft are anticipated to require the cooling of airframe surfaces in the vicinity of the engine exhausts; attention is presently given to the slot pumping, cooling effectiveness, and consequences for thrust of ejector-nozzle schemes. A computer code has been developed to solve for the required ejector slot heights, using models of the slot pumping, secondary air induction, engine cycle, and slot-cooling effectiveness. Results thus obtained are compared with wind tunnel and nozzle test data, and an illustrative engine cycle/aircraft mission profile is considered to demonstrate the inlet/ejector sizing process. O.C.

A91-54081#

ALTERNATIVE DESIGNS/PROPULSION CONCEPTS FOR A LOW-SIGNATURE, SMALL MILITARY TRANSPORT

CHARLES PATTERSON, JON CHAMPION, and KEN SEBEK (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3169)

Three powered lift concepts that could be used on low-signature hover-capable advanced special operations forces aircraft (SOFA) are compared in a conceptual design study conducted by the Air Force Wright Laboratory. The concepts were: lift plus lift/cruise (using advanced high by-pass ratio turbofan lift engines and existing high by-pass ratio turbofan lift/cruise engines); tip-driven lift fans (driven by derivative low by-pass ratio turbofan engines); and shaft-driven lift fans (driven by derivative turboshaft engines) augmented by the powered lift achieved by vectoring both the exhaust of some of the turboshaft engines and the exhaust of ducted cruise fans. The lift plus lift/cruise concept was found to be relatively attractive because, relative to the other powered lift concepts, the lift plus lift/cruise concept led to SOFA designs with substantially smaller size, substantially lower weight, substantially lower allowable hover altitude during payload transfer, better ride quality, and higher optimum cruise speed. C.A.B.

A91-54392

PROPULSION SYSTEMS FOR TWENTY-FIRST CENTURY COMMERCIAL TRANSPORTS

D. T. POWELL (Boeing Commercial Airplane Group, Seattle, WA) (Seminar on 21st Century Aero Engine Design: 1990 Scenario, Cheltenham, England, May 17, 18, 1990) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 205, no. G1, 1991, p. 13-26. refs Copyright

Improvements in the design and performance of subsonic and supersonic commercial transport aircraft during the twenty-first century are reviewed. For subsonic aircraft, the design decisions will be dominated by total reliability and lower maintenance costs, with the engine performance continuing to be a major consideration. The major trend in engine design will be toward larger, higher

thrust engines. The primary propulsion system installation for future supersonic transports are examined. The discussion also covers computational fluid dynamics applications to the propulsion installation, engine/airframe integration, cockpit displays, and control systems. V.L.

A91-54605

AUTOMATIC THROTTLE CONTROL FOR BUSINESS AND COMMUTER AIRCRAFT

DOUGLAS L. BADER (Honeywell, Inc., Business and Commuter Aviation Systems Div., Phoenix, AZ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 205-211.

Copyright

The present digital autothrottle system for application on the Gulfstream IV business jet is the first true full-authority digital autothrottle designed specifically for the business and commuter market. A system description of the Gulfstream IV autothrottle is presented, and attention is given to modes and functions, design tradeoffs, and resulting performance. The autothrottle's modes are: takeoff, go around, flight level change, and speed hold. The primary design tradeoff during development was throttle activity versus control accuracy and dynamic response. The Honeywell design includes several techniques to yield the required accuracy with smooth response and minimal throttle activity. The result is an autothrottle system appropriate for business jets (where passenger comfort is very important). Some of the special considerations involved in designing a digital autothrottle system for use with FADEC (full authority digital engine controls)-controlled engines are discussed. I.E.

A91-54715

NPT 401B RPV TURBOJET

R. W. CHEVIS (Noel Penny Turbines, Ltd., Coventry, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 19.1-19.7.

Copyright

The design, development and test bench running of a new RPV powerplant, the 401B is presented. Specifications include an efficient rated thrust range of 350 lbf to 450 lbf, sea or land recovery, ground launch capability (on trolley or boosted zero length), Mach 0.9 maximum, and operation to 40,000 ft. The gas flow path is composed of an annular axial inlet, centrifugal compressor, reverse flow annular combustor, single stage axial turbine, exhaust diffuser and jet pipe with propelling nozzle. Attention is given to the fuel and control system, electrical power, combustion ignition, and methods of start cranking. R.E.P.

A91-54716

A 40 KW CLASS OF HEAVY FUEL ENGINE FOR UNMANNED AERIAL VEHICLES

E. J. COPLIN (Westland Dynamics, Ltd., Yeovil, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 20.1-20.13. Research supported by Royal Aerospace Establishment, Queen's University of Belfast, and Westland Dynamics, Ltd.

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The design iterations studied to achieve a satisfactory 40 kW multifuel engine capable of operating on fuels ranging from JP4 to the light diesel fuels are presented. Attention is given to the design philosophy, combustion of heavy fuels, rotary combustion engines, number of cylinders and configuration, power ratings with pressure charging, and fuel injection considerations. The final design comprises a two-stroke turbocharged cycle, three inline cylinders, maximum power of 41.5 kW at 4500 rpm, and .194 kg/kW/sfc/hr at maximum power. R.E.P.

A91-55374

A PROGRAM OF EQUIVALENT LABORATORY TESTS FOR TURBINE BLADES [PROGRAMMA EKIVALENTNYKH ISPYTANII LOPATKI TURBINY V LABORATORNYKH USLOVIYAKH]

M. E. KOLOTNIKOV and V. A. SOLIANNIKOV (NPO Trud, Kuibyshev, USSR) Problemy Prochnosti (ISSN 0556-171X), July 1991, p. 89-92. In Russian. refs

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A method for the equivalent testing of turbine blades in the laboratory is proposed which recreates the characteristics of service loading in the maximum-load elements. A procedure for the development of a program of equivalent tests is described using the first-stage blade of a high-temperature gas turbine aviation engine as an example. Some test results are presented. V.L.

A91-55559

ROLE OF CYCLIC TESTING IN THE DEVELOPMENT OF AIRCRAFT GAS TURBINE ENGINES [ULOHA CYKLYKCH ZKOUSEK PRI VYVOJI LETECKYCH TURBINOVYCH MOTORU]

JIRI STATECNY, ANTONIN JANAK, and JAROSLAV DUBSKY Zpravodaj VZLU (ISSN 0044-5355), no. 3, 1991, p. 121-132. In Czech. refs

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With increasing demands on the performance, reliability, and life of gas turbine engines, the low-cycle and time-dependent failure mechanisms become particularly important. Cyclic testing therefore becomes an indispensable part of the development and certification of aircraft powerplants. The philosophy and methodology of cyclic tests and their capabilities are examined in the light of the available experience with domestic and foreign engines. V.L.

A91-56101

INTERNATIONAL SYMPOSIUM ON AIR BREATHING ENGINES, 10TH, NOTTINGHAM, ENGLAND, SEPT. 1-6, 1991, PROCEEDINGS. VOLS. 1 & 2

FREDERICK S. BILLIG, ED. (Johns Hopkins University, Laurel, MD) Symposium sponsored by Rolls-Royce, PLC and International Society for Air Breathing Engines. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. Vol. 1, 718 p.; vol. 2, 644 p. For individual items see A91-56102 to A91-56243.

Copyright

Among the topics discussed are high-speed transport, compressor aerodynamics, environment and pollution, engine performance, computational fluid dynamics, and combustion. Attention is also given to radial flow machines, hypersonic propulsion, engine condition monitoring, cascades and fans, inlets, tribology and materials, and transition and fluid dynamics. Also considered are mixing and mixing control; surge, stall, and flutter; combustion and aerothermodynamics; ram rockets, nozzles; icing and particles; nacelle design; supersonic combustion; scramjet and ramjet; turbines and heat transfer; and energy analysis. B.J.

A91-56102* National Aeronautics and Space Administration, Washington, DC.

PROSPECTS FOR FUTURE HYPERSONIC AIR-BREATHING VEHICLES

H. L. BEACH, JR. and ISAIAH M. BLANKSON (NASA, Washington, DC) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 3-29. refs

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The age of hypersonics is (almost) here. This is evident from the amount of activity in the United States, Europe, the USSR and Japan; this activity is a reflection of technical progress in key areas which will enable new vehicle systems, as well as renewed interest in the utilization of these systems. The current situation, at least in the United States, is the product of an interesting history which is briefly reviewed here. The context for hypersonic applications is discussed, but the emphasis is on hypersonic technology issues and needs, particularly for propulsion and

technology integration. The paper concludes with prospects for accomplishing the objective of air-breathing hypersonic vehicle systems. Author

A91-56104

PW4084 THRUST GROWTH WITH COMMONALITY

B. L. KOFF (Pratt and Whitney Group, West Palm Beach, FL) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 44-53.

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A comprehensive rationalization is presented for the design choices made in the development of the PW4084 high-bypass engine for the B 747-sized, but twin-engined rather than four-engined, B 777 aircraft. The PW4084 is based on the PW4000 engine's core in order to maximize the degree of commonality between the two powerplants. Refinements in low pressure turbine configuration lead to an increase in bypass ratio from the 5.1:1 of the PW4000 to 6.8 in the PW4084; this is associated with a thrust increase from 60,000 to 84,000 lbs. Other divergences from the PW4000 baseline are a shroudless, wide-chord hollow titanium alloy fan blade, a staged combustor for low NOx emissions, and improved turbine cooling. O.C.

A91-56108

TURBINE ENGINE COMBUSTOR DESIGN AT SNECMA

M. DESAULTY (SNECMA, Villaroche, France) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 80-90. refs

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It is emphasized that, following the development of engine cycles and new antipollution constraints, more attention should now be focused on structure and cooling and injection techniques when designing combustors. This paper describes some of SNECMA's research on the technologies and calculation methods needed to meet the performance, cost, and deadline requirements for future engines. Author

A91-56109* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

PROPULSION CHALLENGES FOR A 21ST CENTURY ECONOMICALLY VIABLE, ENVIRONMENTALLY COMPATIBLE HIGH-SPEED CIVIL TRANSPORT

ROBERT J. SHAW (NASA, Lewis Research Center, Cleveland, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 93-103. Previously announced in STAR as N91-23098. refs

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Recent NASA funded studies suggest an opportunity exists for a 21st Century High Speed Civil Transport (HSCT) to become part of the international air transportation system. However, before this opportunity for high speed travel can be realized, certain environmental and economic barrier issues must be overcome. These challenges are outlined. Research activities which NASA has planned to address these barrier issues and provide a technology base to allow the U.S. manufacturers to make an informed go/no go decision on developing an HSCT are discussed. Author

A91-56110

THE EFFECTS ON THE CHARACTERISTICS OF GAS TURBINE COMPONENTS DURING THERMAL TRANSITION

KLAUS-J. SCHMIDT (Hamburg, Universitaet der Bundeswehr, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 104-113. refs

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The purpose of this paper is the investigation of thermal effects

on the characteristics of gas turbine components during transition using the example of the compressor. The investigations are based on measurements. Therefore the two-shaft helicopter engine Lycoming T53-L-13B was used. The measurements consist of the identification of component characteristics at steady state and during the acceleration/deceleration of the engine till reaching a thermal steady state. Analysis models for the determination of heat flux, material temperatures, and clearances are developed. The results of the measurements are compared with the analyzed results of a mean section method considering the transient effects. The results show influences on efficiency and pressure rate. Inaccurate boundary layer models for thermal transition in turbomachines make exacter statements difficult. Author

A91-56111

POTENTIAL OF ULTRA HIGH BYPASS FAN ENGINE HEAT CYCLE ON THE REDUCTION OF FUEL CONSUMPTION AND NOX EMISSION

M. LECHT (DLR, Institut fuer Antriebsstechnik, Cologne, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 114-123. refs

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One aspect in future very high bypass fan engine development is increasing the propulsive efficiency. The other is increasing the thermal efficiency of the core engine. With respect to the Brayton (Joule) heat cycle higher thermal efficiency requires either higher turbine inlet temperatures and pressure ratios, which are unfavorable for the emission rate of nitrous oxides, or modification of the heat cycle itself. A first assessment was made using a simple but flexible thermodynamical model of a fan-engine to study the effect of heat cycle variations such as intercooling, reheating and recuperating. The analysis of the effect of these modifications are made for the cruise design point and referenced to a current high-bypass fan engine. A parametric study of various heat cycle options will be presented, illustrating their influence on optimum bypass ratio, optimum engine pressure ratio, specific fuel consumption, and the emission of nitrous oxides. Author

A91-56113

THE EFFECT OF HUB PASSAGE ON THE PERFORMANCE OF TRANSONIC ROTOR

KAORU CHIBA and KENJI KOBAYASHI (Frontier Aircraft Basic Research Center, Tanashi, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 136-142. refs

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Two types of compressor rotors were tested in order to investigate how the hub-wall profile could influence the performance characteristics of transonic rotors. The experiments were conducted in an axial-flow compressor rig in which the tip Mach number of the rotors was approximately 1.2. The casing radius of the two rotors was held constant. However one rotor had a linear profile at hub-wall whereas the other had a concave profile. The test results showed that the rotor with the concave hub-wall had more flow capacity without sacrificing efficiency levels. The concave hub-wall generated stronger secondary flow to produce a larger pressure ratio near the hub. The overall choking mass flow calculated by viscous flow computation agreed with the test results. Author

A91-56122

THE IMPACT OF AIR TRANSPORT ON THE ENVIRONMENT

M. T. METCALFE, R. A. EATON, and D. M. SNAPE (Rolls-Royce, PLC, Derby, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 221-228. refs

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On a global basis, air transport is widely recognized as making only a small contribution to the atmospheric emissions burden.

This paper considers the impact of these emissions upon the environment and reviews the understanding of the contribution made by aircraft engines to pollution globally, in the vicinity of airports and at high altitudes. The often-conflicting requirements of emissions reduction and the other established combustor performance factors are examined, with particular stress being placed on safety aspects. The concept of an Environmental Impact Parameter (EIP), which would allow the optimization of engine cycle, and combustor design, to minimize the environmental consequences throughout the flight cycle, is introduced. The EIP could take into account the relative environmental importance of each emission species. Author

A91-56123

AIRCRAFT ENGINE NO(X) EMISSIONS - ABATEMENT PROGRESS AND PROSPECTS

D. W. BAHR (GE Aircraft Engines, Cincinnati, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 229-238. refs Copyright

Extensive efforts are currently underway to develop combustors with lower NO(x) emissions for use in both subsonic and supersonic aircraft engines. Basically, NO(x) abatement of any significance requires means of reducing the peak flame temperature within the combustor. To obtain these flame temperature reductions, while also maintaining acceptable combustor performance and operability at low engine power conditions, combustion process staging methods are needed. For use in advanced subsonic aircraft engines, combustors with leaner primary combustion zone fuel/air mixtures, together with combustion process staging features, are being developed. Significant NO(x) level reductions have been demonstrated with these advanced combustor design concepts. Although the resulting combustors are more complex than current technology combustors, satisfactory performance and operability appear attainable. The initial introduction of these combustors into operational engines during the latter part of this decade is likely. In the case of advanced supersonic transport aircraft engines, combustors with ultralow NO(x) levels will probably be needed to prevent adverse impacts on the stratospheric ozone layer. Author

A91-56124

SOOT FORMATION IN CONFINED TURBULENT FLAMES FUELLED BY PRE-VAPORISED KEROSENE AND BY ETHYLENE

K. J. YOUNG, C. D. STEWART, K. J. SYED, and J. B. MOSS (Cranfield Institute of Technology, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 239-248. Research supported by SERC, Ministry of Defence of England, and Rolls-Royce, PLC. refs Copyright

Detailed measurements of mean soot volume fraction, mixture fraction and temperature are reported in turbulent jet flames fueled by prevaporized kerosene and ethylene. A simplified model of soot formation and oxidation, suitable for incorporation into turbulent flame prediction, is described. Detailed comparisons are presented between mean property measurements using optical and probe techniques and computational predictions of the flame flowfield. Author

A91-56127

SIMULATION OF ENGINES FOR HIGH-SPEED CIVIL AIRCRAFTS

G. TORELLA (Accademia Aeronautica, Pozzuoli, Italy) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 269-278. refs Copyright

The problems of the simulation of the engines for high-speed

civil aircraft has been considered for design and off design conditions. Suitable and reliable methods and computer codes have been set up for ramjets and an inverse cycle engine. For the latter, methods derived from the state vector techniques and component matching have been used. The paper deals with the results of design-point and off-design calculations. Author

A91-56128

EXPERIMENTAL ANALYSIS OF THE DYNAMIC PERFORMANCE OF TURBOJET ENGINES

W. BERNIS (BMW Rolls-Royce GmbH, Oberursel, Federal Republic of Germany) and L. FOTTNER (Muenchen, Universitaet der Bundeswehr, Neubiberg, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 279-285. Research supported by BMVg and Bundesamt fuer Wehrtechnik und Beschaffung. refs Copyright

The investigation of dynamic engine performance is becoming progressively more important. The application of experimental analysis is intended to determine as accurately as possible dynamic characteristic quantities based on measured engine parameters taking into account limiting conditions of experimental technology. To this end a test rig was constructed for carrying out computer-controlled load changes with a closed control loop. Correction of dynamic measuring errors required the identification of the measured engine characteristic quantities by means of an inverse signal analysis. Using the identified measured signals as input parameters, the dynamic performance was analyzed with the aid of an experimental engine model. Author

A91-56131

DISTINGUISHING THE AIR-BREATHING JET ENGINE THRUST AND THE AERODYNAMIC FORCES

I. S. SIMONOV (Tsentr'al'nyi Aerogidrodinamicheskii Institut, Zhukovski, USSR) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 321-325. refs Copyright

Aspects of decomposition of the total force applied to an ABJ powered aircraft into the aerodynamic force and the engine thrust are examined. The ABJ thrust is defined as a difference between the exhaust jet impulse and the inlet-captured air impulse. Any other force component is to be included in the total aerodynamic force. The equations derived make it possible to reveal the effects of the engine air flow on the aerodynamic forces/moments when testing a model in a wind tunnel or computing a flow pattern around a flight vehicle. Author

A91-56136

COMBUSTOR DEVELOPMENT FOR ADVANCED HELICOPTER ENGINE

F. JOOS, B. SIMON, B. GLAESER, and S. DONNERHACK (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 363-371. Research supported by BMFT. refs Copyright

Turboshaft engines and smaller turbojet engines often are designed with reverse-flow annular combustors (compactness, short overall length). For an engine in the 1000-kW category, an extremely short, compact reverse-flow annular combustor is designed and tested. The development effort includes optimization of both air blast atomizers and wall cooling concepts. The combustor was developed with the aid of water simulation rig tests and multidimensional flow-field models. The temperature distribution across the combustor, the combustion efficiency, the stability of the flame and the material temperatures are all measured

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in a realistic engine environment. The combustor ignites without difficulty also under simulated cold-start conditions. Author

A91-56137

FLAME STABILITY AND LEAN BLOWOUT

G. J. STURGEON, D. G. SLOAN (Pratt and Whitney Group, East Hartford, CT), W. M. ROQUEMORE, V. K. REDDY, D. SCHOUSE, A. L. LESMERISES (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH), D. R. BALLAL, S. P. HENEGHAN, M. D. VANGSNESS (Dayton, University, OH), and P. O. HEDMAN (Brigham Young University, Provo, UT) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 372-384. refs
(Contract F33615-87-C-2767; F33615-90-C-2033; F33615-87-C-2822)

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A progress report is presented on a comprehensive research program aimed at improving the design and analysis capabilities for flame stability and lean blowout in the combustors of aircraft gas turbine engines. The motivation and aims of the program are reviewed, and the unusual approach adopted to address the research issues is outlined. The supporting experimental program and the test vehicles involved are described, together with some major results obtained to date. The modeling techniques that are being explored are summarized. Their potential and limitations are highlighted. Author

A91-56140

ON THE PERFORMANCE OF A SMALL, CONVENTIONAL COMBUSTOR BURNING A VARIETY OF FUELS

D. KRETSCHMER, G. WANG, J. ODGERS (Universite Laval, Quebec, Canada), and G. PEARCE (Defence Science and Technology Organisation, Aeronautical Research Laboratories, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 403-410. refs

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This paper is concerned with the correlation of combustion efficiency for a small conventional combustor (987 points) for a wide range of fuels at atmospheric pressure and for a wide range of operating conditions using a single fuel. An important finding was that droplet size was not necessary for the correlation. The correlation was also applied to data for three other combustors reported by other workers. Author

A91-56155

ENGINE TECHNOLOGIES FOR FUTURE SPACEPLANES

P. KRAMMER and R. R. SCHWAB (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 549-558. Research supported by BMFT and ESA. refs

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In order to be able to successfully design and build an airbreathing hybrid propulsion system for hypersonic applications a number of enabling technologies will have to be developed. Within the German Hypersonic Technology Programme technological efforts are focused on the two-stage-to-orbit Saenger concept. It is the objective of this paper to discuss the importance of propulsion generic technologies and to put them into perspective with regard to system performance and safety aspects. These technological requirements include aerothermodynamics of inlets and nozzles, hydrogen combustion and environmental effects, thermal management, and high-temperature and hydrogen resistant materials and structures. Author

A91-56157

THE EFFECTS OF AGING OF ENGINE STRUCTURAL INTEGRITY IN RELATION TO FLIGHT OPERATIONS

A. B. RICHTER and MIKE TSAO (Science Applications International Corp., San Diego, CA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 569-572. Copyright

There have been over 10,000 JT8D engines delivered to United States commercial airlines with multiple air-frame applications on the B-727, B-737, and DC-9 fleets. The JT8D engine inventory is approaching 20 years of operational exposure and the expected continued use of this inventory warrants a review of the future structural integrity of critical engine components, primarily engine cases. This study used in-flight shutdown and engine removal rates as two operational reliability performance parameters suitable for documenting the performance history of the engine. This operational performance trending was taken together with a review of Federal Aviation Agency Service Difficulty Reports to identify specific component failures producing JT8D engine reliability problems. Some of these component failures require configuration enhancement, while other engine components need improved inspection procedures, and several components suffered from poor maintenance practices. The JT8D engine structural integrity goal for engine cases was approached by the development of an ultrasonic inspection procedure for case drain bosses. This NDI procedure is used on-wing for installed engines. The Ultra Image III procedure provides 240 degree circumferential coverage of the drain boss weld area. This computer-enhanced ultrasonic inspection procedure provides a color graphic display of the inspection findings and a permanent documented history of the inspection results. Author

A91-56158

ADAPTIVE MODELING OF JET ENGINE PERFORMANCE WITH APPLICATION TO CONDITION MONITORING

K. MATHIOUDAKIS, A. STAMATIS, K. PAPAILIOU (Athens, National Technical University, Greece), and B. LAMBIRIS IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 573-579. refs

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A method for simulating the performance of jet engines, with the possibility of adapting engine particularities, is presented; it employs an adaptation procedure coupled to a performance model solving the component-matching problem. The proposed method can provide accurate simulation for engines of the same type, but differing due to manufacturing or assembly tolerances, and doesn't require accurate component maps, as they are derived during the adaptation procedure. It can also be used for health monitoring purposes, for component fault identification and condition assessment. The effectiveness of the proposed method is demonstrated by application to two commercial jet engines. Author

A91-56160

SOME INVESTIGATIONS INTO THE CONDITION MONITORING OF MECHANICAL COMPONENTS IN GAS TURBINE ENGINES

J. E. NICKS and G. KRISHNAPPA (National Research Council of Canada, Ottawa) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 591-598. refs

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Gas turbine engine condition monitoring has been carried out to diagnose the condition of individual mechanical components of gas turbine engines using vibration analysis. Vibration analysis was carried out on spur gears run on a gear fatigue test rig from data acquired during normal endurance test runs and during seeded fault trials. A Stewart Hughes MSDA and NRC-developed amplitude and phase modulation techniques were employed for analysis.

The amplitude/phase modulation techniques showed improved sensitivity to early faults. Rub induced rotor/stator vibration studies were carried out on a CF700 gas turbine engine. Time- and frequency-domain analysis methods were used to identify the changes in the levels at blade passing frequencies and other dominant peaks. Amplitude and phase modulation techniques were employed successfully to identify the rub effects. Allison T56 engines were used as test engines for the vibration analysis research. Preliminary analysis has been carried out and component visibility has been established. Baseline signatures of almost all gear components were visible in a good engine, while bearings were difficult to identify. Author

A91-56165

COMBUSTION AND NO EMISSIONS IN A TURBULENT DUMP COMBUSTOR

F. BIAGIOLI and C. BRUNO (Roma, Università, Rome, Italy) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 630-639. refs
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An analysis of performance and emissions for a H₂/air dump combustor is presented to assess the effects of operating a conventional ramjet at high Mach number and altitude. The turbulent combustion processes are modeled by conventional eddy viscosity and using a conserved scalar coupled with fast chemistry approach, with conservation equations solved utilizing a novel iterative technique. The results obtained by a parametric study of the effect of inlet air velocity indicate that mixing and efficiency may be maximized by increasing inlet air velocity; this, however, creates high NO levels. Reducing air velocity lowers NO emissions substantially, but also reduces efficiency and tends to enhance temperature fluctuations. Author

A91-56166

THE REDUCTION OF SMOKE FROM THE ALLISON T56 GAS TURBINE ENGINE

F. W. SKIDMORE (Defence Science and Technology Organisation, Aeronautical Research Laboratory, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 640-644. Research supported by Royal Australian Air Force and Qantas. refs
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A research and development program is described that reduced smoke emissions from the Allison T56 turboprop gas turbine engine is described. The results obtained demonstrate smoke reductions of the order of up to 80 percent, and the engine's specific fuel consumption has been reduced by up to 1 percent. Author

A91-56167

THE INFLUENCE OF WATER INJECTION INTO THE COMBUSTOR ON THE THRUST AND EMISSION PERFORMANCE OF THE BY-PASS ENGINE

A. ANDREEV, E. MARCHUKOV, V. OSOBOV, and V. CHEPKIN (NPO Liul'ka, Moscow, USSR) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 645-649. refs
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The results of experimental investigations on the influence of water injection into the combustor primary zone of a by-pass gas turbine engine on its operation and the level of nitric oxide ejection are presented. The investigations were performed on the AL-31F engine. The considerable influence of water injection into the combustor on the level of nitric oxide ejection has been noted. When water flow rate was equal to fuel flow rate the ejection quantity of nitric oxide was decreased more than 10 times. A water-feed system has been developed which passed the bench tests with the AL-31F engine and showed high efficiency and operational reliability. Author

A91-56171

DESIGN AND TEST RESULTS OF A HIGH PERFORMANCE SINGLE STAGE COMPRESSOR

J. PAULON, J. C. BEDOT (ONERA, Chatillon, France), Z. ZHANG, P. JIA, and J. MENG (Shenyang Aeroengine Research Institute, People's Republic of China) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 678-685. refs
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The design and research of a high performance single stage axial transonic compressor is discussed. The objective of the project is to utilize and develop a three-dimensional computational code with viscous effect simulation. An advanced single stage compressor based on this algorithm was designed, manufactured and tested. The test results indicated satisfactory performances. In the paper a brief description is given of the aerodynamic compressor design, test facilities, and instrumentation and a comparison is made between calculation and test results. Author

A91-56173

AEROTEK'S TURBINE DESIGN AND ANALYSIS CAPABILITY

W. J. LOUW, P. SENATORE, and S. S. SZEWCZUK (Council for Scientific and Industrial Research, Div. of Aeronautical Systems Technology, Pretoria, Republic of South Africa) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 692-699. refs
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The present gas turbine engine development program consists of a suite of design and analysis computer programs and complementary experimental facilities. This infrastructure was created under severe budgetary and manpower constraints. A description of the various phases of the design and analysis approach is given. This includes a description of the programs that were obtained, updated or developed, and the procedure in which they are used. A description of the experimental facilities used to complement the analytical approach is also presented. Author

A91-56183

ALL-COMPOSITE FAN BLADE FOR ADVANCED DUCTED ENGINES

J. FRISCHBIER and S. SIKORSKI (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 780-787. refs
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A counter-rotating integrated shrouded propfan is being investigated. This paper gives an overview of the development activities on fiber composite fan blades. Two types of composite blades have been designed - a full size blade (2.5 meter fan diameter) and a scaled one. The blade construction for both types consists of an all-composite CFRP blade fitted into a metallic fork-shaped root. Natural frequencies and mode shapes were determined by holographic methods, modal analysis, and vibration tests. The aeroelastic stability of the blades was analyzed with finite element methods including an aerodynamic routine for the calculation of unsteady loads in unstalled subsonic and supersonic flow. The fatigue strength of the composite/metal-connection at the blade root and its fail safe behavior is being tested with CFRP/titanium-specimens. To prove the bird strike potential of the blades the bending strength of carbon/epoxy and APC2 (PEEK) at high strain rates was measured. Shooting tests of plasticine masses on composite plates were used to calibrate the 'DYNA3D' finite element bird strike analysis. Author

A91-56195* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SUPERSONIC MIXING AND COMBUSTION IN SCRAMJETS

G. B. NORTHAM (NASA, Langley Research Center, Hampton, VA), D. P. CAPRIOTTI (Analytical Services and Materials, Inc., Hampton, VA), C. S. BYINGTON (Pennsylvania State University, University Park), and I. GREENBERG (Rafael Armament Development Authority, Haifa, Israel) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 892-897. refs

Experimental and theoretical studies are being conducted to explore techniques to enhance mixing in scramjet combustors using parallel fuel injection from the base of swept and unswept wall-mounted ramps. The experiments reported herein were conducted using Mach 2 and 3 combustor inlet conditions. Supporting computational and cold flow studies indicated that the observed enhanced mixing for the swept ramp configuration is primarily due to the substantially higher degree of vorticity and entrainment generated by the swept trailing edges. Author

A91-56197

SUPPRESSION OF COMBUSTION INSTABILITIES BY ACTIVE SHEAR-FLOW/COMBUSTION CONTROL

K. C. SCHADOW, E. GUTMARK, T. P. PARR, and K. J. WILSON (U.S. Navy, Naval Weapons Center, China Lake, CA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 917-924. refs

Pressure oscillations were suppressed and lean flammability limits were extended for a dump combustor operating near atmospheric pressure, using controlled fuel modulations. The closed-loop combustion control was obtained by the disruption of large-scale structure development at the dump, as visualized in ducted-flame experiments. The limitation of the control effectiveness for multifrequency oscillations is discussed. Author

A91-56198

AXIAL COMPRESSOR PERFORMANCE DURING SURGE

I. J. DAY (Cambridge, University, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 927-934. Research supported by Rolls-Royce, PLC and SERC. refs Copyright

The flow conditions in an axial compressor during surge are not well documented in the open literature. This paper presents detailed measurements from a low speed test rig which has been instrumented to pick-up both axial and circumferential disturbances. The results show that surge is initiated by rotating stall, and that subsequent events take place in a well-ordered, cause-and-effect sequence. The differences in cycle behavior between classic surge and deep surge are illustrated, and it is shown that the shape of the compressor characteristic determines which of these will occur. From the results, it is concluded that overall pressure rise and size of hysteresis loop are important factors which are neglected in current techniques for predicting the rotating stall/surge boundary. Author

A91-56202* Purdue Univ., West Lafayette, IN.

AERODYNAMIC DETUNING FOR AEROELASTIC CONTROL OF STABILITY AND FORCED RESPONSE OF SUPERSONIC ROTORS

KAREN M. SPARA and SANFORD FLEETER (Purdue University, West Lafayette, IN) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 961-971. Research supported by NASA and USAF. refs Copyright

An unsteady aerodynamic model is developed to analyze flutter and aerodynamically forced response of aerodynamically detuned supersonic axial flow rotors. Alternate blade aerodynamic detuning is considered, accomplished by alternating the circumferential spacing of adjacent blades as small solidity variations which do

not have a dominant effect on the steady performance of a rotor. The unsteady aerodynamics are determined by developing an influence coefficient technique which is appropriate for both aerodynamically tuned and detuned rotor configurations. Torsion mode rotor stability and aerodynamically forced response are then analyzed with this unsteady aerodynamic model by combining it with a single-degree-of-freedom structural model. The effects of this detuning on the flutter and forced response characteristics of supersonic axial flow rotors is then demonstrated by considering baseline twelve bladed rotors. Author

A91-56205

GEOMETRICAL DEPENDENCE OF THE FLUID DYNAMIC PERFORMANCE PARAMETERS OF PLANE COMBUSTOR MODEL DIFFUSERS

R. HESTERMANN, S. KIM, and S. WITTIG (Karlsruhe, Universitaet, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 995-1001. Research supported by DFG. refs Copyright

Results of an experimental study on the influence of dominant geometrical parameters as well as of different entry conditions on the aerodynamic performance of combustor diffusers for advanced gas turbine engines are presented. The experiments were conducted in a plane combustor model diffuser consisting of a straight walled pre-diffuser followed by a dump diffuser with a flame tube under cold flow conditions. The results for symmetrical inlet conditions show that the most important parameters to achieve stable flow conditions with low losses are the distance of the flame tube dome from the pre-diffuser exit, the height of the flame tube channels, and the pre-diffuser area ratio. In addition to the analysis of the relevant parameters it is shown to be possible to force a separated flow to reattach by reducing the height of the flame tube channels or by reducing the flame tube distance, respectively. Author

A91-56206

EXPERIMENTAL INVESTIGATION OF THE TURBULENCE CHARACTERISTICS IN A TWO-DIMENSIONAL DUMP-TYPE COMBUSTOR MODEL

A. MANJUNATH, B. H. L. GOWDA, and R. NATARAJAN (Indian Institute of Technology, Madras, India) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1002-1010. refs

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In a two-dimensional dump-type model of a combustion chamber commonly employed in ramjets, the effect of the variation of the dump angle on the turbulence characteristics is investigated here. Experiments have been performed for inlet angles of 15 deg, 30 deg, 45 deg and 60 deg, for an approach Reynolds number (referred to the inlet width) of 10 to the 5th. The inlet angle is found to have a significant effect on the turbulence field in the combustor. The turbulence kinetic energy decays much more rapidly for inlet angles of 45 deg and more than for smaller angles, leading to more intense mixing. The distributions of the various components of the Reynolds stress tensor are presented here for an inlet angle of 45 deg. Author

A91-56209

APPLICATION OF 3D CFD TECHNIQUES TO GAS TURBINE COMBUSTOR METAL TEMPERATURE PREDICTIONS

J. COUPLAND, P. FRY, and R. A. KING (Rolls-Royce, PLC, Derby, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1026-1034. refs

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The application of three-dimensional computational fluid dynamics to conjugate heat transfer calculations for various

geometries relevant to gas turbine combustors is described. The method used is based on an orthogonal curvilinear grid finite-volume Nakier-Stokes code using the k-epsilon turbulence model, and including the solution of the energy equation in areas of the solution domain excluded from the flow. Heat transfer results are presented for two simplified, but three-dimensional, models of the geometries considered, and compared with measurements obtained using a liquid crystal paint technique. Flow and metal temperature results are presented for the component geometries considered, and the application of the methods to improved design of the various components is described. Author

A91-56216
DESIGN AND PERFORMANCE EVALUATION OF NOVEL EXHAUST SYSTEMS - A NUMERICAL STUDY

SUSAN X. YING (Florida State University, Tallahassee), CHOUDARY R. BOBBA, and JAMES L. YOUNGHANS (GE Aircraft Engines, Cincinnati, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1083-1089. refs Copyright

A computational fluid dynamics method is applied to evaluate the performance characteristics of an unconventional nozzle. The results of this parametric study indicate that the secondary pressure ratio has a significant effect on the shock wave structure of the nozzle flow. A comparison of the estimated surface characteristics with experimental data indicate good agreement. The detailed flow visualization of the calculations reveals interesting interaction of the ejector flow with the primary flow of the nozzle. The estimated thrust characteristics and their variation with secondary pressure ratios agree satisfactorily with measured data. Author

A91-56217
OPTIMIZATION OF HYPERSONIC THRUST NOZZLES

E. ECKERT, M. GOEING, and H. SCHEITL (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1090-1099. refs Copyright

In this paper, critical areas in the aerodynamic design of a single expansion ramp nozzle are identified. Particular emphasis is placed on the additional use of secondary air flow ejection in order to improve nozzle performance at off-design conditions. The paper describes a simple method for predicting the two-dimensional ejector nozzle flowfield, and presents first calculation results for the transonic flight range. Hydraulic experiments are used to illustrate the basic effects. Author

A91-56218
TURBORAMJET EXHAUST NOZZLE SYSTEMS

D. J. DUSA (GE Aircraft Engines, Cincinnati, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1100-1110. refs Copyright

Advancements in aircraft propulsion system technology over the past decade (in materials, structures, and analytical design methods), along with those anticipated for the next decade, have renewed interest in the Mach 4.0 to 6.0 operating regime for both commercial transports and military weapon systems. One of the propulsion systems being considered for these applications is the dual-mode turboramjet engine, which utilizes a common inlet and exhaust nozzle for both modes of operation. A number of component technologies will have to be developed before these Mach 4.0 to 6.0 applications become a reality; this paper addresses the technologies that will have to be developed for one of those components: the exhaust nozzle system. Author

A91-56219
ASPECT-RATIO EFFECTS ON INFRARED RADIATION INTENSITY OF 2-D NOZZLE EXHAUST PLUME

YOKICHI SUGIYAMA, KATSUMI ADACHI, and ISAO TOKAJI (Japan Defense Agency, Technical Research and Development Institute, Tachikawa) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1111-1115. refs Copyright

Aspect-ratio effects on IR radiation intensity from two-dimensional nozzle exhaust plume have been experimentally investigated using scale models of roughly 1/20 of an actual one. The experiment was conducted using a newly-developed apparatus which provides high temperatures burning gases to the model with external flow, simulating afterburner operation in flight. An axisymmetric nozzle has also been tested to make relative comparison. The IR measurement has been done in the middle IR spectrum band (3 to about 5 microns) to observe CO₂ emission characteristics of the plumes. The results show that the IR intensity from the exhaust plume tends to reduce with increasing aspect ratios of the two-dimensional nozzles and is definitely weaker than that from the axisymmetric nozzle. However, the radiation from the hot inner walls becomes significantly strong enough to destroy the trends. Author

A91-56226
THE EFFECT OF PROBABILISTIC RESTITUTION CHARACTERISTICS OF PARTICLE SURFACE INTERACTIONS ON THE PARTICLE DYNAMICS IN AXIAL FLOW TURBINES

A. HAMED and W. TABAKOFF (Cincinnati, University, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1166-1174. refs (Contract NSF CTS-90-12309) Copyright

An investigation is conducted to study the probabilistic characteristics of particle surface interaction and their influence on the particle dynamics and blade erosion in an axial-flow turbine. The variance in the particle-rebounding velocities after surface impacts, as determined from the experimental measurements using LDV in a special particulate flow tunnel are simulated in the particle dynamics computations. Bootstrap sampling of the experimental restitution data sets for empirical rebound correlations constitute the basis of the Monte Carlo probabilistic simulations of particle surface interactions in the particle trajectories computations through the turbine blade passages. Presented results demonstrate the influence of the variance in the particle restitution characteristics on the frequency of surface impacts, impacting velocities and the associated blade erosion. Author

A91-56232
EFFECTS OF INJECTOR GEOMETRY ON SCRAMJET COMBUSTOR PERFORMANCE

NOBUO CHINZEI, TOMOYUKI KOMURO, KENJI KUDOU, ATSUO MURAKAMI, KOUICHIRO TANI, GORO MASUYA, and YOSHIO WAKAMATSU (National Aerospace Laboratory, Kakuda, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1219-1227. refs Copyright

An experiment was conducted to investigate mixing and combustion characteristics in a scramjet combustor, with an emphasis on effect of fuel injector geometry under an entrance Mach number of 2.5. The length of the constant height section downstream of injection orifices had a strong influence, but the sweep of the rearward-facing step had little effect on the combustor performance. Reversing the steps opposing each other did not show any advantages. The role of the backward-facing step in suppressing the upstream propagation of pressure waves was identified by comparing the present results with a correlation derived

earlier. The fuel jets injected from the model with the longest constant height section and the fuel equivalence ratio of unity coalesced at a very early stage downstream of the fuel injection orifices. This led to decrease in mixing growth rate downstream, despite the high degree of mixing near the injection orifices. The combustion efficiencies were higher than those obtained at NASA Langley near the injection orifices. Downstream of the combustor, however, the present data were overcome by the Langley's mixing correlation because of the above-mentioned reduced mixing growth rate. The peak wall pressure and the distance of upstream influence correlated well irrespective of the injector geometry and total temperature of air, except at 1000 K. Author

A91-56233

COMBUSTION TEST AND THERMAL ANALYSIS OF FUEL INJECTION STRUTS OF A SCRAMJET COMBUSTOR

TOMOYUKI KOMURO, YOSHIO WAKAMATSU, ATSUO MURAKAMI, KENJI KUDOU, KOUICHIRO TANI, GORO MASUYA (National Aerospace Laboratory, Kakuda, Japan), YUKIO YAMAOKA, KAZUYOSHI NINOMIYA, KATUAKI KOSAKA, and NOBORU SHINOZAKI (Nissan Motor Co., Ltd., Kawagoe, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1228-1233. refs

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Results of exploratory tests of single strut fuel injectors are presented and analysed. Also thermal analyses of strut leading edge are discussed. In this study perpendicular and parallel injection were studied on the conditions of stagnation temperatures 1000 K - 2500 K, a total pressure 1.0 MPa, and injected equivalence ratio 0 - 0.8. These conditions simulated the flight Mach numbers 4.5 - 7.5. Thermal analyses were performed on some leading edge configurations because sharp edges were desired for the air flow but received higher heat flux than that of blunt edges. Main purposes of this study were to determine mixing properties and fluid mechanical properties effects on fuel equivalence ratio of parallel injection to perpendicular injection and to analyse heat flux over the strut leading edge and performance of active cooling. Author

A91-56234 General Applied Science Labs., Inc., Ronkonkoma, NY.

ONGOING TESTING OF SUPERSONIC COMBUSTION RAMJET (SCRAMJET) COMBUSTORS AT SIMULATED HYPERSONIC FLIGHT CONDITIONS IN PULSE FACILITIES

R. C. ORTH and J. I. ERDOS (General Applied Science Laboratories, Inc., Ronkonkoma, NY) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1237-1249. Research sponsored by National Aero-Space Plane Joint Program Office and NASA. refs

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Since 1985 GASL has conducted a series of semi-direct-connect H2 fueled scramjet combustor tests, in which the last part of the inlet flow was partially simulated by an approximate Mach 10 free jet flow from the nozzle of the Calspan Corporation shock tunnel. In 1989 GASL commissioned its HYPULSE Test Facility, an expansion tube wind tunnel which was formerly operated at NASA Langley Research Center during the 1970's. Using techniques that are similar to those described above, GASL is also conducting semi-direct connect scramjet combustor tests on somewhat smaller axisymmetric and two dimensional models at simulated Mach 13 to 17 flight conditions. GASL's experiences in acquiring, analyzing and interpreting test data from these two seminal test programs are discussed. Typical data are presented. The problems associated with derivation of combustor performance from the measurable parameters are indicated, and one approach to determination of combustion efficiency based on incremental changes between nonreacting and reacting flow data is discussed. Author

A91-56237

AERODYNAMIC DEVELOPMENT OF AN HP-TURBINE FOR ADVANCED TURBOSHAFT ENGINES

H.-J. DIETRICH, F. MALZACHER, and K. BROICHHAUSEN (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1269-1275. refs

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Results of extensive cold air rig and annular cascade tests with a highly-loaded single-stage high-pressure turbine carried out in an HP-turbine technology and demonstrator program are presented. The influence of transonic stator/rotor choking characteristics and tip clearance effects on turbine performance are discussed based on cold flow rig and demonstrator engine test results. Author

A91-56240

SECONDARY AND EMERGENCY POWER OPTIONS FOR ADVANCED FIGHTERS

C. RODGERS (Sundstrand Power Systems, San Diego, CA) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1293-1301. refs

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High performance aircraft of the future will demand more compact, lighter weight secondary power units (SPU's) capable of providing faster starts and rapid response over previously impenetrable flight operating envelopes. Propulsion technology advancements continue to task the design and optimization of SPU's to the point, where during a flight emergency, power must be regained in a few seconds under all flight altitudes and attitudes. Ever increasing altitude operational requirements are limiting the viability of airbreathing SPU's, consequently hybrid units are being evolved capable of operating in both airbreathing and non-airbreathing modes. This paper highlights the various secondary power unit design options for advanced fighters, including a small hybrid gas turbine secondary power unit for dual mode capability for either non-airbreathing (stored energy) or conventional airbreathing operations. Data are presented verifying successful mode transition at rated speed, and recommendations are suggested for further research and development in dual mode operational technology. Author

A91-56242

SECOND LAW APPROACH TO COMBUSTION IN RAMJET

A. Y. GOGUS and I. S. AKMANDOR (Middle East Technical University, Ankara, Turkey) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1313-1318. refs

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The internal energy loss in combustion chamber of a ramjet has been examined through analysis of entropy generation. A method is described, for applying the principle of minimum-rate-of entropy production to combustion instability analysis. Numerical solution of the one-dimensional unsteady Euler equation, with friction and heat addition, by the method of characteristics, shows that when inlet total pressure fluctuation is above a limiting amplitude, the signal is amplified, and that at the same time, the entropy generation decreases. Author

A91-56244

INTERNATIONAL SYMPOSIUM ON AIR BREATHING ENGINES, 10TH, NOTTINGHAM, ENGLAND, SEPT. 1-6, 1991, SUPPLEMENTARY PAPERS

Symposium sponsored by Rolls-Royce, PLC and International Society for Air Breathing Engines. Bristol, England, Rolls-Royce, PLC, 1991, 97 p. For individual items see A91-56245 to A91-56250.

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Papers presented include an ongoing development strategy from the RB-211 to the Trent, propulsion for supersonic STOVL aircraft, and the emerging requirements for dual and variable cycle engines. Also presented are the precombustion shock wave as a means of the working process control in a supersonic combustion chamber, and European collaboration in aero-engine research. R.E.P.

A91-56245

BRINGING TECHNOLOGY TO THE MARKET PLACE

MICHAEL G. J. W. HOWSE IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 27 p.

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A review is presented of the ongoing aeroengine technological advances being introduced into the commercial air transport industry. Bringing technology to the business community efficiently involves devising market programs where generic and product specific technologies are developed in a timescale compatible with the introduction of new and derivative products at an acceptable cost and risk. Consideration is given to airline operating benefits achieved from recent aeroengine design improvements, wide chord fan blade developments and how civil engines might evolve as a result of future advances in materials, aerodynamics and manufacturing technology. R.E.P.

A91-56246

FROM RB211 TO TRENT - AN ONGOING DEVELOPMENT STRATEGY

C. HORNBLLOWER (Rolls-Royce, PLC, Derby, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 27 p.

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The design, development and evolution of the RB-211 turbofan engine and its derivatives are presented. This engine, introduced in 1968 at a takeoff thrust rating of 40,600 lb, was unique in having three separate shaft systems with the fan, intermediate and high pressure compressors each driven by their own separate turbines. Attention is focused on the latest Trent engine derivative in the 70,000 lb thrust class and the continuing growth potential in future developments. R.E.P.

A91-56247

PROPULSION FOR SUPERSONIC STOVL AIRCRAFT

W. J. LEWIS (Rolls-Royce, PLC, Bristol, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 8 p.

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A review is presented of various propulsion concepts proposed to power a supersonic STOVL aircraft. The different concepts considered include vectored thrust, ejector lift, remote augmented lift, tandem fan, lift plus lift/cruise, remote gas driven fan-in-wing, and shaft driven remote fan. Attention is given to some aircraft configurations and the requirements of performance factors that influence powerplant selection. R.E.P.

A91-56248

THE EMERGING REQUIREMENTS FOR DUAL AND VARIABLE CYCLE ENGINES

K. R. GARWOOD and D. R. BALDWIN (Rolls-Royce, PLC, Bristol, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 22 p.

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Problems confronting engine designers for advanced aircraft focusing on the challenges of low and high Mach number flight of the multirole fighter are presented. Consideration is given to the variable cycle engine that adds extra degrees of freedom such that fuel consumption, thrust or both may be better optimized over a range of flight points. Attention is given to the major

operational requirements of the multirole fighter aircraft and the flight envelope that determines the temperature range over which the engine must operate. R.E.P.

A91-56251

INTERNATIONAL SOCIETY FOR AIR BREATHING ENGINES - COMMEMORATION VOLUME 1970-1991

Washington, DC, American Institute of Aeronautics and Astronautics, 1991, 156 p. No individual items are abstracted in this volume.

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Citations and abstracts are presented for papers on air-breathing-engine technology presented at the first 10 ISABE International Symposia (1972-1991). Also included in the volume are the constitution and bylaws of the organization and lists of the countries and institutions which have supported ISABE, the executive committee members, and the winners of ISABE awards. D.G.

A91-56455

DESIGN AND EXPERIMENTAL STUDY OF THE DIFFUSER FOR THE EXHAUST DUCT OF A GAS TURBINE ENGINE

JUN LIN and YI SHANG (Nanjing Aeronautical Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 23, Sept. 1991, p. 79-86. In Chinese. refs

The diffuser for the exhaust duct of the gas turbine engine has been investigated experimentally. The paper presents two development design methods to modify a diffuser shape of the same outside dimensions under use. The experimental results show that the performance of the exhaust duct can be significantly improved by using the developed design methods. But by confining to the outside dimensions of the original diffuser, the advantages of the two design methods cannot be brought into full play. The design methods developed for the exhaust diffuser may be applied to the practical engineering. Author

A91-56899

STUDY OF PROPULSION FOR HIGH VELOCITY FLIGHT

V. A. SOSUNOV (Tsentr'al'nyi Nauchno-Issledovatel'skii Institut Aviatsionnogo Motorostroeniia, Moscow, USSR) Rolls-Royce, PLC and International Society for Air Breathing Engines, International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Paper. 17 p. refs

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Results are presented of experimental investigations of turboramjets operation under conditions of $M = 4-4.5$ flight, with the turbofan running on liquid hydrogen, together with methods for observing its effective burning in afterburning and ramjet combustion chambers. The different schemes of scramjet are considered, and methods and results of mathematical modeling of in-scramjet-duct processes from inlet up to nozzle are presented. The test facilities intended to scramjet models research and some experimental results are shown. Author

N91-31144# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Propulsion and Energetics Panel.

LOW TEMPERATURE ENVIRONMENT OPERATIONS OF TURBOENGINES (DESIGN AND USER'S PROBLEMS)

1990 373 p Partly in FRENCH and ENGLISH Presented at the Propulsion and Energetics Panel 76th Symposium, Brussels, Belgium, 8-12 Oct. 1990

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The papers presented at the Propulsion and Energetic Panel 76th Symposium and the discussions represent a significant contribution to improved cold weather tolerant and anti-icing design and to safer aircraft operation in a low temperature environment. The following subject areas are covered: cold weather operational experience and requirements, system design considerations, fuel effects and lubricants behavior, and icing condition and testing.

07 AIRCRAFT PROPULSION AND POWER

N91-31145# Army Air Corps, Stockbridge (England). School of Aeronautical Engineering.

LOW TEMPERATURE ENVIRONMENT OPERATION OF TURBO ENGINES: A MILITARY OPERATOR'S EXPERIENCE AND REQUIREMENTS

M. SUMMERTON *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 3 p 1990

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The United Kingdom's commitment to NATO includes the regular use of Royal Marine and Army helicopters in low temperature conditions. The operation of the Westland LYNX helicopter is addressed with its Rolls Royce GEM engines during winter deployments in Norway where the near-arctic conditions present certain operating and working difficulties. These difficulties are considered both generally, from a human and physical point of view, and then more specifically with regard to the engines themselves. Finally, a few areas for improvements are discussed, with the emphasis on reliability, ease of maintenance, and effective development and testing before entry into service. Author

N91-31146# Canadian Forces Base Cold Lake, Medley (Alberta). Base Aircraft Maintenance Engineering Organization.

LOW TEMPERATURE ENVIRONMENT OPERATIONS OF TURBO ENGINES

CHRISTIAN OUELLETTE *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 3 p 1990

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The following subject areas are covered: (1) the climate conditions in Canada; (2) a summary of the Operational and Maintenance community of the Canada Armed Forces operational role and commitments; (3) maintenance problems and practices associated with the cold weather environment; (4) the 'Hung Start' problem associated with CF-18. GE-F404 engines; and (5) the status of the infamous J-85-CAN-15 compressor stall problem. Author

N91-31147# Flugplatz Butzweilerhof, Cologne (Germany, F.R.). **ANALYSIS OF STARTING PROBLEMS IN COLD WEATHER WITH ASTAZOU TYPE TURBINE ENGINES IN HELICOPTERS [ANALYSE DES PROBLEMES DE DEMARRAGE PAR TEMPS FROID AVEC LES TURBOMOTEURS D'HELISOPTERE DE TYPE ASTAZOU]**

W. PIETERS *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 6 p 1990 *In* FRENCH; ENGLISH summary

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During the heavy winter periods in the beginning of the 80th, the Belgian army had considerable starting problems on its helicopters ALOUETTE equipped with ASTAZOU turbo engines. The different detection methods of the phenomena employed by the users, the immediate actions undertaken by the army, and the solutions worked out in collaboration with the constructors as well as their budgetary consequences are discussed. Author

N91-31148# Fokker B.V., Schipol-Oost (Netherlands). Environmental Control and Ice Protection Systems.

VULNERABILITY OF A SMALL POWERPLANT TO WET SNOW CONDITIONS

R. MEIJN *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 6 p 1990

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Several temporary flame-out incidents were experienced in descent through light icing conditions and precipitation during regular scheduled flights. Extensive ground testing of the engine indicated less tolerance to ice ingestion than was demonstrated in engine certification tests. Powerplant ice protection was enhanced by additional anti-icing of the engine flexible seal by

bleed air. Factors are discussed influencing unexpected ice formation and associated uncertainties in the qualification process of a small turboprop powerplant. Author

N91-31149# Boeing Canada, Toronto (Ontario).

ICE TOLERANT ENGINE INLET SCREENS FOR CH113/113A SEARCH AND RESCUE HELICOPTERS

R. B. JONES and W. A. LUCIER *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 11 p 1990 Sponsored in part by National Research Council of Canada

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The Canadian Forces CH113/113a Search and Rescue Helicopters occasionally encounter unavoidable icing conditions in their operating environment. The original engine inlet safeguards were not designed for nor capable of sustained operations in icing environments, necessitating removal of the inlet screens in these conditions. This arrangement resulted in unacceptable risk of foreign object damage to the engine, and compromised operational safety. Ice tolerant inlet screens were developed as a remedy for this problem. The flat faced, inverted cone screens with a bypass opening accommodate progressive ice congestion during the various operational modes with minimum engine performance degradation. Author

N91-31150# Sundstrand Turbomach, San Diego, CA.

COLD STARTING SMALL GAS TURBINES: AN OVERVIEW

C. RODGERS *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 22 p 1990

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The requirements to operate aircraft gas turbines over a large range of environmental conditions prove particularly demanding to the systems designer, especially when rapid starting of a cold engine is stipulated at sub-zero ambient temperature. As a consequence the occurrence of cold climatic extremes are discussed and a trend is observed toward designing aircraft for specific areas and deployment, rather than worldwide usage. Cold engine cranking torque characteristics are basically controlled by the lubricant viscous drag in the mechanical drive train and accessories. This viscous drag is dependent upon the magnitude of the applied start torque. Experience with start system for small gas turbine Auxiliary Power Units (APU's) showed that the total weight required for successful starting at -54 C can approach the weight of the APU powerhead itself. As a consequence, most cold start requirements are relaxed to -40 C or higher. Methods for reducing APU viscous drag and start energy requirements that deserve future study are the all electric gearbox-less APU, and the possibility of a self-start combustor concept. Author

N91-31151# Hans-Sachs-Str., Groeben Zell (Germany, F.R.).

COLD START OPTIMIZATION ON A MILITARY JET ENGINE

H. GRUBER *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 5 p 1990

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Cold-starting testing at temperatures of approximately -40 C was performed on 2 RB 199 engines at a West Germany altitude test facility. The engines were of the same build standard with exception of the seal configuration (labyrinth or brush), and running times. One part of the test was performed with F34 fuel, the other with F40. The facilities, test methods, and test results are presented. Author

N91-31152# Pratt and Whitney Aircraft of Canada Ltd., Mississauga (Ontario).

COLD WEATHER IGNITION CHARACTERISTICS OF ADVANCED SMALL GAS TURBINE COMBUSTION SYSTEMS

I. CRITCHLEY, P. SAMPATH, and F. SHUM *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and

User's Problems) 7 p 1990

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Low temperature and high altitude starting requirements of present day small aero-gas turbine engines are discussed from the viewpoint of their influence on the design of the combustors and ignition systems. Use of electric starters, common in small engines, creates particular challenges to starting especially under cold soak sea level and altitude startup conditions. The main factors in combustion system design affecting starting performance are discussed, including combustor sizing, fuel placement, fuel atomization, fuel scheduling, and igniter selection. Low emission requirements may adversely affect starting performance, necessitating use of elaborate fuel/ignition systems, some recent developments are described. Author

N91-31153# General Electric Co., Peebles, OH.

**COLD WEATHER JET ENGINE STARTING STRATEGIES
MADE POSSIBLE BY ENGINE DIGITAL CONTROL SYSTEMS**

R. C. WIBBELSMAN /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 14 p 1990

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The advent of the computing power of digital controls now makes it possible to achieve a major step forward in the controls systems ability to cope with the multiplicity of situations confronting the engine starting system designer. One of strategies that could be employed is presented, used by the GE and CFMI Commercial Family of large high bypass ratio turbofan engines. Numerous variations of this basic concept could be employed. Author

N91-31154# KHD Luftfahrttechnik G.m.b.H., Oberursel (Germany, F.R.). Thermodynamics and Performance Dept.

**COLD START INVESTIGATION OF AN APU WITH ANNULAR
COMBUSTOR AND FUEL VAPORIZERS**

K. H. COLLIN /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 18 p 1990

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The combustor of the APU (Auxiliary Power Unit) for the Tornado fighter aircraft is described. As this APU has to cope with the narrow space in the fuselage it must be of a small size. An annular combustor is favorable as it is short and can be integrated into the envelope of the outer diameter. The fuel vaporizing system is chosen because of its great advantages with combustion. The ignition process is described which is difficult because no fuel is actually vaporized when the start is initiated. Theoretical background and experimental steps of a development program are reported. The result was perfect starting of this system down to -40 C and a very high 'First Start Reliability' which means no false start leading to several start procedures. Author

N91-31155# Pratt and Whitney Aircraft, West Palm Beach, FL.
**CONTROL SYSTEM DESIGN CONSIDERATIONS FOR
STARTING TURBO-ENGINES DURING COLD WEATHER
OPERATION**

ROBERT R. POLLAK /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 10 p 1990

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Starting turbo-engines at climatic extremes has always presented challenges to the systems engineer. The wide range of both ambient and engine internal temperatures experienced by many influential variables increase the complexity of the startup process both on the ground and in the air. The content of this paper provides the current status of advanced control methods designed specifically to address combustor ignition and quick, stall-free acceleration to idle. Sensitivity of combustor ignition limits to cold conditions as well as fuel types was accommodated by both the combustor fuel delivery system and control system design.

Specific attention is also given to starting at cold altitude conditions with extremely hot as well as extremely cold internal engine temperatures. Successfully meeting these requirements was accomplished by designing the control system to automatically monitor external influential variables as well as engine internal parameters both prior to and during the actual startup cycle and using these data to continuously adjust fuel scheduling to obtain optimum startup characteristics. Author

N91-31156# Pratt and Whitney Aircraft of Canada Ltd., Mississauga (Ontario).

**COLD START DEVELOPMENT OF MODERN SMALL GAS
TURBINE ENGINES AT PRATT AND WHITNEY AIRCRAFT OF
CANADA LTD.**

D. S. BREITMAN and F. K. YEUNG /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 7 p 1990

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Engine cold start capability is essential for aircraft in Arctic or winter operations. Demonstration of this capability is part of the engine development and certification requirements. Variables such as the combustor design, the diffuser exit flow characteristics, and the compressor performance at sub-idle conditions all affect the cold start capability of an engine. How these factors are usually optimized is briefly described, and an overview of the successful PW305 Engine cold start development (with an electric starter) is presented. The PW305 is a new turbofan engine from Pratt & Whitney of Canada in the 5000 lb thrust range. Author

N91-31157# Wehrtechnische Dienststelle fuer Luftfahrzeuge, Manching (Germany, F.R.).

**DESIGN CONSIDERATIONS BASED UPON LOW
TEMPERATURE STARTING TESTS ON MILITARY AIRCRAFT
TURBO ENGINES**

H.-F. FEIG /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 16 p 1990

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Test experience on engine low temperature starting was obtained in the course of multinational and national trials to assess weapon system performance. The objective of the trials was to recommend a clearance for the weapon system. In order to carry out these tests adequately, the operational role of the weapon system had to be considered and the operational limits of the engines and associated systems had to be known. Parameters influencing low temperature start capabilities were reviewed and experience gained from the tests was discussed. Author

N91-31158# Canadian Forces Headquarters, Ottawa (Ontario).

**CLIMATIC CONSIDERATIONS IN THE LIFE CYCLE
MANAGEMENT OF THE CF-18 ENGINE**

R. W. CUE and D. E. MUIR (GastOPS Ltd., Ottawa, Ontario) /In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 15 p 1990

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The Canadian Forces have developed an Engine Parts Life Tracking System (EPLTS) to define the scheduled maintenance requirement of CF-18 aircraft engine components. Up to 64 components are tracked by this system, 26 of which are life limited on the basis of 8 different Life Usage Indices defined by the engine manufacturer and evaluated during each operational mission by the aircraft's Inflight Engine Condition Monitoring System. Data on the rates of component life consumption collected by the EPLTS during a full 12 month time span were analyzed. The manner and extent to which seasonal effects might influence these life consumption rates and hence the life cycle management of the engine are presented and discussed. Author

07 AIRCRAFT PROPULSION AND POWER

N91-31159# Rolls-Royce Ltd., Leavesden (England).
**APPLICATION OF A WATER DROPLET TRAJECTORY
PREDICTION CODE TO THE DESIGN OF INLET PARTICLE
SEPARATOR ANTI-ICING SYSTEMS**

D. L. MANN and S. C. TAN (Cranfield Inst. of Tech., Bedford, England) *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 11 p 1990
Sponsored in part by Ministry of Defence
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Over the past five years, a dust particle trajectory code has been developed. Recent work on the code to include an ice accretion prediction model suitable for use as a design aid for a wide variety of gas turbine engine inlets, but particularly for particle separator geometries is described. The calculation of the local heat transfer coefficient is seen to be critical to the success of the ice accretion prediction. The incorporation of a suitable model is described, and a series of validation tests, carried out on a full scale rig, were shown to satisfactorily verify the code. A second series of validation experiments, carried out in an icing facility, further shows the prediction model to be appropriate. Author

N91-31160# General Motors Corp., Indianapolis, IN. Gas Turbine Div.

**DEVELOPMENT OF AN ANTI-ICING SYSTEM FOR THE
T800-LHT-800 TURBOSHAFT ENGINE**

GARY V. BIANCHINI *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 13 p 1990

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The T900-LHT-800 is a modern technology 1200 hp (900 kW) class turboshaft engine developed for the U.S. Army's LH helicopter and various civil applications. One of its significant features is an integral inlet particle separator (IPS). The presence of an IPS significantly complicates development of an anti-icing system for protection against the hazards associated with ice formation during operation in environmental icing conditions. The T800 engine is described, and the anti-icing system requirements, design evolution, and validation testing are discussed. The final anti-icing system configuration resulting from the development effort is presented. Author

N91-31161# Rolls-Royce Ltd., Derby (England).

ENGINE ICING CRITICALITY ASSESSMENT

E. BROOK *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 6 p 1990

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Assessment of an engine design for icing risk is important at both the design stage and for development and certification testing. Icing must be included with aerodynamic and noise constraints during the design phase to minimize the risk of design change during development, and the compromise tested must be tested at the extremes of the atmospheric icing, and aircraft and engine operating envelopes most appropriate to the particular components. The type of assessment necessary is addressed and illustrated mainly by reference to high bypass ratio turbofans. The approach to identifying critical conditions is presented and areas where research can provide basic data for the development of design methods are discussed. Author

N91-31162# General Electric Co., West Lynn, MA. Aircraft Engines Div.

**ICE INGESTION EXPERIENCE ON A SMALL TURBOPROP
ENGINE**

L. W. BLAIR, R. L. MILLER, and D. J. TAPPARO *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 9 p 1990

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Modern high technology turbine aircraft engines often employ high rotor speed compressors with thin advanced blading designs

to achieve better performance. The engine designer is faced with a tradeoff between optimum compressor performance and on-wing durability. During the engine/aircraft development stage, certain assumptions are made regarding the icing environment and the testing required to confirm compatibility with it. Often, the true impact of the design trade-off is not realized until the engine is exposed to its service environment. Despite successful engine test cell and aircraft natural icing certification tests, in 1984 General Electric Aircraft Engines Company began to experience an unacceptable level of foreign object damage (FOD) caused by ingested ice with its CT7-5/-7 family of turboprop engines. The purpose of this paper is to: (1) address the issue of Stage one compressor rotor blade ice FOD in the CT7 engine; (2) explain the methods and techniques used in assessing the icing environment; (3) explain the lessons learned from test and analysis; and (4) define the final resolution of the compressor maintenance problem which simultaneously created accelerated performance deterioration for the engine. The first part of this paper deals with the airframe icing environment and its impact on the engine inlet system. The second part concentrates on the design improvement and durability testing of the Stage one compressor blade. Author

N91-31163# Ministry of Defence, London (England).

**FUELS AND OILS AS FACTORS IN THE OPERATION OF
AERO GAS TURBINE ENGINES AT LOW TEMPERATURES**

G. L. BATCHELOR *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 7 p 1990

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Two factors strongly influence the low temperature behavior of aero gas turbine fuels and oils: viscosity and state or phase change - i.e. whether the material is liquid or solid. In fact, the question is whether solids are, or are not, present because, although the whole may cease to flow at some designated temperature, the lighter components of hydrocarbon and other organic mixtures are likely to be liquids under all natural circumstances. Terms such as freezing point, pour point, and the like, will be familiar enough; the chemical and physical realities underlying such parameters are examined, and their impact on aero gas turbine engine performance is considered. For the purposes of this paper, fuels and oils will be treated quite separately. Author

N91-31164# Southwest Research Inst., San Antonio, TX.

**THE EFFECT OF FUEL PROPERTIES AND ATOMIZATION ON
LOW TEMPERATURE IGNITION IN GAS TURBINE
COMBUSTORS**

D. W. NAEGLI, L. G. DODGE, and C. A. MOSES *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 10 p 1990 Sponsored in part by Naval Air Propulsion Center

(Contract DAAK70-85-C-0007; DAAK70-87-C-0043)

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Experiments were conducted in a T63 engine combustor to gain a better understanding of the role played by volatility and atomization in low temperature ignition. Eight test fuels were used, some of which were specially blended to vary either viscosity or volatility while holding the other constant. Six atomizers were used to vary the fuel spray characteristics, and average drop sizes, represented by Sauter mean diameter (SMD), were measured. Air temperatures were varied from 239 to 310 K. Ignition comparisons were made by the minimum fuel-air ratios necessary to achieve ignition. Significant results included: (1) viscosity, which determined atomization characteristics, was more important than volatility in the ignition process; (2) ignition depended more on achieving a critical drop size than on reaching the lean-limit fuel-air ratio; and (3) fuel temperature was found to be more important than air temperature for low-temperature ignition, an effect due principally to viscosity and atomization rather than evaporation. A practical

implication is that fuel heating would give a much greater improvement in cold-start performance than heating the combustor inlet air. Author

N91-31165# Royal Military Coll. of Canada, Kingston (Ontario). Dept. of Mechanical Engineering.

THE INFLUENCE OF FUEL CHARACTERISTICS ON HETEROGENEOUS FLAME PROPAGATION

M. F. BARDON, J. E. D. GAUTHIER, and V. K. RAO *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 9 p 1990

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A theoretical study of flame propagation through mixtures of fuel vapor, droplets, and air under conditions representative of cold starting in gas turbines is discussed. Two previously developed models are described: one for heterogeneous flame propagation and the other for describing the complex evaporative behavior of real fuel blends. Both models were validated against experimental data. The combined model incorporates the effects of pressure, temperature, droplet diameter, turbulence intensity, delivered equivalence ratio, fuel prevaporization, and fuel type on flame propagation. Differences in the combustion performance of Jet A1, JP-4, and two single component reference fuels are compared. Conclusions are drawn regarding the use of pure compounds to represent real fuel blends, and the relative importance of various engine conditions and spray parameters on combustion. Author

N91-31166# Naval Air Propulsion Test Center, Trenton, NJ.

THE DEVELOPMENT OF A COMPUTATIONAL MODEL TO PREDICT LOW TEMPERATURE FUEL FLOW PHENOMENA

R. A. KAMIN, C. J. NOWACK, and B. A. OLMSTEAD (Boeing Military Airplane Development, Seattle, WA.) *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 13 p 1990 Sponsored by ONR

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Fuel availability studies indicated that the relaxation of the F-44 freeze point specification could greatly increase the yield of F-44 per barrel of crude. A thorough analysis was initiated to insure that the higher freeze point fuel would not form solid wax precipitates during low temperature operations that could impact aircraft mission performance. In order to evaluate the effects of a potential change in the freeze point specification over the entire inventory of United States naval aircraft, a general three dimensional computational fluid dynamics code, PHOENICS 84, was modified for use. Inputs into the code include tank geometry, mission profile, and fuel properties. Outputs from the model include fuel cooldown and holdup, as a function of time in the tank. The accuracy of the code was verified by experimental data obtained during flight and simulator testing of instrumented tanks. Author

N91-31167# Naval Air Propulsion Test Center, Trenton, NJ.

ENVIRONMENTAL ICING TESTING AT THE NAVAL AIR PROPULSION CENTER

WILLIAM H. REARDON and VITO J. TRUGLIO *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 18 p 1990

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A comprehensive Environmental Icing Simulation System developed by the Naval Air Propulsion Center (NAPC) is discussed. The system accommodates the testing of ducted and free stream mounted engines and free stream mounted engine inlets. The Navy specification icing test procedures, success criteria and rationale for the requirements are discussed. Also discussed are the capabilities of the NAPC icing facilities in terms of critical icing cloud parameters such as liquid water content, mean effective droplet diameter, humidity and inlet air temperature. How the icing environment is established, calibrated prior to testing, and verified during testing are covered. NAPC test experience in the Navy qualification programs for the T406, T700, and F404, as well as

demonstration and development test programs performed with the TOMAHAWK Cruise Missile inlet and the F-14A aircraft inlet duct are discussed. Author

N91-31168# Rolls-Royce Ltd., Derby (England). **ICING RESEARCH RELATED TO ENGINE ICING CHARACTERISTICS**

S. J. RILEY *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 12 p 1990

Copyright Avail: NTIS HC/MF A16; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Physical properties and characteristics of ice formed by accretion were investigated experimentally to provide a database relevant to civil turbofan engine and powerplant surfaces. Part of that work, relating to unheated surfaces, including observations of ice accretion on various bodies over a range of conditions, and measurement of the adhesive strength of ice samples is discussed. Author

N91-31169# Centre d'Essais des Propulseurs, Orsay (France).

NUMERICAL MODEL OF EVOLUTION IN SUPERCOOLED CLOUD OF WATER DROPLETS IN A CASE OF ICING [MODELISATION NUMERIQUE DE L'EVOLUTION D'UN NUAGE DE GOUTTELETTES D'EAU EN SURFUSION DANS UN CAISSON GIVRANT]

PAUL CREISMEAS and JOEL COURQUET (Office National d'Etudes et de Recherches Aeronautiques, Toulouse, France) *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 10 p 1990 *In* FRENCH; ENGLISH summary

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A computational tool, called M.A.G.I.C., developed as a tool for icing tests is discussed. In order to compare numerical results from M.A.G.I.C. to physical measurements, an analysis based on granulometry measurement of droplets inside a wind tunnel was performed. The results of the comparison were acceptable. Author

N91-31170# Sverdrup Technology, Inc., Arnold AFS, TN.

ICING TEST CAPABILITIES FOR AIRCRAFT PROPULSION SYSTEMS AT THE ARNOLD ENGINEERING DEVELOPMENT CENTER

C. SCOTT BARTLETT, J. RICHARD MOORE, NORMAN S. WEINBERG, and TED D. GARRETSON (Arnold Engineering Development Center, Arnold Air Force Station, TN.) *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 9 p 1990

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Icing test capabilities for the full scale turbine engine propulsion systems at the Engine Test Facility (ETF) at the Arnold Engineering Development Center (AEDC) are discussed. The methods and hardware used to inject liquid spray into a cold airstream to simulate in-flight icing conditions are discussed. The spray manifold systems and spray injection nozzles currently in use at AEDC are described. Test experiences in both direct and free-jet connect icing tests are addressed. Recent ice accretion scaling techniques and test results, and developments and observations in cloud liquid water content and droplet sizing are briefly discussed. Uses of real time ice accretion detectors for facility calibration and test article ice accretion rate monitoring are addressed. Author

N91-31171# Aero and Industrial Technology Ltd., Burnley (England). Combustion Technology Centre.

ICING TEST PROGRAMMES AND TECHNIQUES

E. CARR and D. WOODHOUSE *In* AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 8 p 1990

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Described here are the capabilities of an altitude test facility with a main chamber 4m diameter by 12 m long and capable of

07 AIRCRAFT PROPULSION AND POWER

providing air flows up to 5kg/s and simulating altitudes up to 15 km. The experience obtained on icing programs since the plant was commissioned in 1953 is described. Examples of the procedures used to establish the susceptibility of equipment to icing are given. The examples cover the use of scale models, the evaluation of probes, and the testing of complete helicopter engine intakes.

Author

N91-31174 Boeing Canada, Toronto (Ontario).

SEGMENTED ROTATABLE NOZZLES Patent Application

DOUGLAS GARLAND, inventor 8 Feb. 1990 37 p
(CA-PATENT-APPL-SN-2-009-634;
INT-PATENT-CLASS-F02G-140; INT-PATENT-CLASS-B64C-2900;
CTN-91-60136) Copyright Avail: Micromedia Ltd., Technical
Information Centre, 165 Hotel de Ville, Place du Portage, Phase
2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

A thrust deflector is provided for use with vertical/short take off and landing (VSTOL) aircraft having pressurized gas generators. The thrust deflector consists of a number of adjacent nozzles. Each of the nozzles has a body with a first and a second face. The nozzles further have an inlet for receiving pressurized gas from the gas generator and at least one outlet connected to the inlet for discharging pressurized gas from the nozzle. Each of the nozzles is rotatable from a first position in which the outlet directs pressurized gas downward to a second position in which the outlet directs pressurized gas rearward. In the first position, the first and second faces of the bodies of adjacent nozzles are spaced apart to permit air to flow between the nozzles. In the second position, the first and second faces of adjacent nozzles are in contact preventing air passage between adjacent nozzles. The thrust deflector may be mounted on stub wings along either side of the fuselage or in a chordwise arrangement in the main wing of the aircraft. Lower ejector doors may be rotatably mounted adjacent to the nozzles distal to the fuselage and the nozzles suitably spaced to cause thrust augmentation according to the ejector principle.

CISTI

N91-31175 Boeing Canada, Toronto (Ontario).

SEGMENTED VECTORING CRUISE NOZZLES Patent Application

DOUGLAS GARLAND, inventor and JOSEPH E. FARBRIDGE, inventor 8 Feb. 1990 36 p
(CA-PATENT-APPL-SN-2-009-635;
INT-PATENT-CLASS-F02K-178; CTN-91-60137) Copyright
Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel
de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2,
Canada HC \$4.00 CAN, MF \$2.75 CAN

A thrust vectoring structure is provided for vertical/short take off and landing (VSTOL) aircraft having a pressurized gas generator and at least one rearward facing outlet with an opening for discharging pressurized gas from the pressurized gas generator. This structure has a plurality of horizontal dividers extending between the sides of the opening. A front flap is rotatably mounted adjacent to the front edge of the dividers and a rear flap is similarly mounted adjacent the rear edge of the dividers. The flaps are rotatable from a horizontal position to a vertical position. In the horizontal position the pressurized gas is directed rearwardly. In the vertical position the pressurized gas is directed downwardly in a number of discrete segmented jets. The flaps are further rotatable so that they diverge outwardly in either the horizontal or the vertical positions. In one embodiment, the top of the outlet is also rotatable toward or away from the bottom to vary the cross sectional area of the outlet.

CISTI

N91-31176 Boeing Canada, Toronto (Ontario).

VENTRAL SEGMENTED NOZZLES Patent Application

JOSEPH E. FARBRIDGE, inventor, DOUGLAS GARLAND, inventor, A. R. SCHEXNAYDER, inventor, BRIAN E. MEYER, inventor, and CHARLES F. RITCHIE, inventor 8 Feb. 1990 21 p Prepared in cooperation with Canadian General Electric Co. Ltd., Toronto, Ontario
(CA-PATENT-APPL-SN-2-009-636;
INT-PATENT-CLASS-F02K-100; INT-PATENT-CLASS-B64C-2900;

CTN-91-60138) Copyright Avail: Micromedia Ltd., Technical
Information Centre, 165 Hotel de Ville, Place du Portage, Phase
2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

A thrust directing system is provided for vertical or short takeoff and landing (VSTOL) aircrafts having a pressurized gas generator. The thrust directing system consists of a number of spaced, downwardly facing openings along the bottom of the fuselage. The openings are fluidly connected with the outlet of the aircraft engine so that pressurized gas from the aircraft engine is discharged through the openings and away from the fuselage in discrete, spaced jets. The openings can be provided with at least one vectoring flap for further directing the heat being discharged through the opening. The flap is movable to direct the heat from a vertical direction to at least one rearward direction. Air introduction means may also be provided which fluidly communicate with the space between the nozzles.

CISTI

N91-31177 Boeing Co., Seattle, WA.

REMOVABLE SLIDER SHOE FOR A TRANSLATING SLEEVE USED ON A JET ENGINE COWL AND DUCT Patent

ALFRED H. GREIERT, inventor 3 Jan. 1989 12 p
(PATENT-1-247-868; INT-PATENT-CLASS-F16C-2902;
CTN-91-60151) Copyright Avail: Micromedia Ltd., Technical
Information Centre, 165 Hotel de Ville, Place du Portage, Phase
2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

An improved low friction bearing surface for a translating sleeve used on a jet engine cowl and duct was devised. It consists of a removable slider shoe for mounting on a translating sleeve of a jet engine cowl and duct. The sleeve has a slider which moves in a track on the cowl. The shoe is comprised of: a removable element adapted for receipt of a slider for sliding along the length of the track; a second removable element having a portion of its outer periphery adapted for receipt of the slider for sliding along the length of the track; a low friction surface on the outer periphery of each shoe element; and removable means for securing and replacing the shoe elements and the slider. The claimed shoe elements are made from a low friction rub surface bonded to aluminum. This invention eliminates the time and expense of removing a solid molded shoe attached to the slider when the slider becomes worn. The removable shoe can be quickly removed and replaced.

CISTI

N91-31179# Aeronautical Research Labs., Melbourne (Australia).

FIELD EVALUATION OF SIX PROTECTIVE COATINGS APPLIED TO T56 TURBINE BLADES AFTER 500 HOURS OF ENGINE USE

S. G. RUSSO Jun. 1991 26 p
(ARL-MAT-TM-405; AR-006-615) Copyright Avail: NTIS HC/MF A03

The evaluation of several protective coatings that were applied to IN738-LC first stage turbine blades in two military gas turbines for an interval of 500 flight hours indicated variations in the extent of hot-corrosion resistance. The coatings included two conventional nickel aluminides, an aluminide modified with chromium, a platinum-modified aluminide, an aluminide modified with silicon and a platinum/rhodium-modified aluminide. The aim of this trial is to find a coating that will withstand up to 3000 engine operating hours. Detailed metallographic examinations as well as scanning electron microscopy were employed in the evaluation. Results indicated that the precious metal aluminides offered the best protection with the chromium-aluminide being the most susceptible to hot-corrosion. The conflicting results of the basic aluminide coatings reaffirms the point that no firm conclusions can be made solely on one assessment. Furthermore, there was no apparent cracking in any of the coatings.

Author

N91-31181*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, OH.

JET-A REACTION MECHANISM STUDY FOR COMBUSTION APPLICATION

CHI-MING LEE, KRISHNA KUNDU, and WALDO ACOSTA (Army Aviation Systems Command, Cleveland, OH.) 1991 13 p

Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-27 Jun. 1991; cosponsored by AIAA, SAE, ASME, and ASEE Previously announced in IAA as A91-45810 (Contract DA PROJ. 1L1-62211-A-47A) (NASA-TM-104441; E-6279; NAS 1.15:104441; AVSCOM-TR-91-C-029; AIAA-91-2355) Avail: NTIS HC/MF A03 CSDL 21/5

Simplified chemical kinetic reaction mechanisms for the combustion of Jet A fuel was studied. Initially, 40 reacting species and 118 elementary chemical reactions were chosen based on a literature review. Through a sensitivity analysis with the use of LSENS General Kinetics and Sensitivity Analysis Code, 16 species and 21 elementary chemical reactions were determined from this study. This mechanism is first justified by comparison of calculated ignition delay time with the available shock tube data, then it is validated by comparison of calculated emissions from the plug flow reactor code with in-house flame tube data. Author

N91-32136# Wyoming Univ., Laramie.
REVIEW OF AIR FORCE COMPRESSOR BLADE AND VANE REWORK AND ITS IMPACT ON PERFORMANCE AND COSTS
ROBERT A. WHEASLER May 1990 60 p
(AD-A229518; WRDC-TM-90-203-POTX) Avail: NTIS HC/MF A04 CSDL 01/3

The first successful powered flight of an aircraft was a direct result of the development of an engine to propel the aircraft. Since that time engineers have been faced with challenges to develop improved propulsive devices. Although the basic principles of the gas turbine engine are understood, its operation seems oversimplified to some. The problems involved in developing a high-performance engine include applications of nearly every engineering discipline. The development of the gas turbine engine to its present stage is a result of the vast amount of research that has taken place during the past fifty years, as was the case in the development of the propeller-reciprocating engine. The demands for a high-performance engine have resulted in a high sophisticated design which can only be successful through utilization of all the latest technologies. GRA

N91-32137# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
COST EFFECTIVENESS OF TWO VERSUS THREE LEVELS OF MAINTENANCE FOR TURBINE ENGINES IN THE AIR FORCE INVENTORY M.S. Thesis
JOHN T. SCHIEFEN Sep. 1990 100 p
(AD-A229622; AFIT/GLM/RQ/90S-49) Avail: NTIS HC/MF A05 CSDL 21/5

This study examined the life cycle costs (LCC) for Air Force turbine engines. Specifically, the research compared the costs for two, three, and modified three level maintenance concepts. To achieve the research objectives, a LCC model, the Super Operating and Support Cost Model (SOSCM), was used. SOSCM is used by the Propulsion SPO, ASD/YZ, at Wright Patterson AFB to estimate costs for Air Force engines. A sensitivity analysis was run on a generic test case to determine the effect of changes in certain cost drivers on LCC. There were a few important findings. First, for this case, the LCC for the two level concept was 14.7 pct. greater than the cost for three levels of maintenance. Two factors accounted for most of the difference. The number of spare engines required increased, the second destination transportation costs rose sharply. The study also showed that changes in some factors have a greater impact on the costs for two levels of maintenance than three. Overall, the research points out that it should not be assumed that moving to two levels of maintenance will lower costs. Engine types should be considered individually to determine the most cost effective maintenance concept. GRA

N91-32138*# Detroit Diesel Allison, Indianapolis, IN.
INVESTIGATION OF ADVANCED COUNTERROTATION BLADE CONFIGURATION CONCEPTS FOR HIGH SPEED TURBOPROP SYSTEMS. TASK 3: ADVANCED FAN SECTION GRID GENERATOR FINAL REPORT AND COMPUTER PROGRAM USER'S MANUAL Final Report, Feb. - Jun. 1991

ANDREW J. CROOK and ROBERT A. DELANEY Sep. 1991
111 p Original contains color illustrations
(Contract NAS3-25270)
(NASA-CR-187129; NAS 1.26:187129) Avail: NTIS HC/MF A06;
3 functional color pages CSDL 21/5

A procedure is studied for generating three-dimensional grids for advanced turbofan engine fan section geometries. The procedure constructs a discrete mesh about engine sections containing the fan stage, an arbitrary number of axisymmetric radial flow splitters, a booster stage, and a bifurcated core/bypass flow duct with guide vanes. The mesh is an h-type grid system, the points being distributed with a transfinite interpolation scheme with axial and radial spacing being user specified. Elliptic smoothing of the grid in the meridional plane is a post-process option. The grid generation scheme is consistent with aerodynamic analyses utilizing the average-passage equation system developed by Dr. John Adamczyk of NASA Lewis. This flow solution scheme requires a series of blade specific grids each having a common axisymmetric mesh, but varying in the circumferential direction according to the geometry of the specific blade row. Author

N91-32139# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne (Germany, F.R.). Abt. Triebwerkssysteme.
THERMODYNAMIC FLOW DESCRIPTION OF A RAMJET FOR DETERMINATION OF ENGINE FORCES AND MOMENTS
FRANS G. J. KREMER Jan. 1991 155 p In GERMAN;
ENGLISH summary Report will also be announced as translation ESA-TT-1266
(DLR-FB-91-02; ISSN-0939-2963; ETN-91-90038; ESA-TT-1266)
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB PL DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 55.50 DM

A theoretical calculation model for a ramjet is described. This model serves for performance calculations for a supersonic flight vehicle. These performance calculations require determination of the forces and moments of the ramjet. The engine forces and moments are determined from the flow conditions of the engine. Therefore the flow conditions are determined at characteristic planes. The used suppositions and assumptions are described in detail. It is important to define which forces are engine and which forces are flight vehicle specific. This is called bookkeeping. Furthermore the order of magnitude of several parameters is given. Variation of these parameters, performed by means of a computer program, gives insight into the connexion and the mutual interactions. ESA

N91-32140*# National Aeronautics and Space Administration.
Hugh L. Dryden Flight Research Facility, Edwards, CA.
PRELIMINARY FLIGHT EVALUATION OF AN ENGINE PERFORMANCE OPTIMIZATION ALGORITHM
H. H. LAMBERT, G. B. GILYARD, J. D. CHISHOLM, and L. J. KERR (Pratt and Whitney Aircraft, West Palm Beach, FL.)
Washington Oct. 1991 19 p Presented at the 27th Joint Propulsion Conference, Sacramento, CA, 24-26 Jun. 1991; cosponsored by AIAA, ASME, SAE, ASEE Previously announced in IAA as A91-44089
(NASA-TM-4328; H-1745; NAS 1.15:4328) Avail: NTIS HC/MF A03 CSDL 21/5

A performance seeking control (PSC) algorithm has undergone initial flight test evaluation in subsonic operation of a PW 1128 engined F-15. This algorithm is designed to optimize the quasi-steady performance of an engine for three primary modes: (1) minimum fuel consumption; (2) minimum fan turbine inlet temperature (FTIT); and (3) maximum thrust. The flight test results have verified a thrust specific fuel consumption reduction of 1 pct., up to 100 R decreases in FTIT, and increases of as much as 12 pct. in maximum thrust. PSC technology promises to be of value in next generation tactical and transport aircraft. Author

N91-32141*# Gordon (Sanford), Cleveland, OH.
THE NAVY/NASA ENGINE PROGRAM (NNEP89):
INTERFACING THE PROGRAM FOR THE CALCULATION OF
COMPLEX CHEMICAL EQUILIBRIUM COMPOSITIONS (CEC)
Final Report

SANFORD GORDON Sep. 1991 24 p Prepared in cooperation with Sverdrup Technology, Inc., Brook Park, OH (Contract NAS3-24105) (NASA-CR-187208; NAS 1.26:187208) Avail: NTIS HC/MF A03 CSCL 21/5

The NNEP is a general computer program for calculating aircraft engine performance. NNEP has been used extensively to calculate the design and off-design (matched) performance of a broad range of turbine engines, ranging from subsonic turboprops to variable cycle engines for supersonic transports. Recently, however, there has been increased interest in applications for which NNEP is not capable of simulating, such as the use of alternate fuels including cryogenic fuels and the inclusion of chemical dissociation effects at high temperatures. To overcome these limitations, NNEP was extended by including a general chemical equilibrium method. This permits consideration of any propellant system and the calculation of performance with dissociation effects. The new extended program is referred to as NNEP89. Author

N91-32717*# Lightning Technologies, Inc., Pittsfield, MA.
DESIGN OF LIGHTNING PROTECTION FOR A
FULL-AUTHORITY DIGITAL ENGINE CONTROL

M. DARGI, E. RUPKE, and K. WILES /n NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 12 p Aug. 1991 Avail: NTIS HC/MF A20 CSCL 21/5

The steps and procedures are described which are necessary to achieve a successful lightning-protection design for a state-of-the-art Full-Authority Digital Engine Control (FADEC) system. The engine and control systems used as examples are fictional, but the design and verification methods are real. Topics discussed include: applicable airworthiness regulation, selection of equipment transient design and control levels for the engine/airframe and intra-engine segments of the system, the use of cable shields, terminal-protection devices and filter circuits in hardware protection design, and software approaches to minimize upset potential. Shield terminations, grounding, and bonding are also discussed, as are the important elements of certification and test plans, and the role of tests and analyses. Also included are examples of multiple-stroke and multiple-burst testing. A review of design pitfalls and challenges, and status of applicable test standards such as RTCA DO-160, Section 22, are presented. Author

N91-32718*# Lightning Technologies, Inc., Pittsfield, MA.
CERTIFICATION OF LIGHTNING PROTECTION FOR A
FULL-AUTHORITY DIGITAL ENGINE CONTROL

M. DARGI, E. RUPKE, and K. WILES /n NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 9 p Aug. 1991 Avail: NTIS HC/MF A20 CSCL 21/5

FADEC systems present many challenges to the lightning protection engineer. Verification of the protection-design adequacy for certification purposes presents additional challenges. The basic requirements of the certification plan of a FADEC is to demonstrate compliance with Federal Airworthiness Regulations (FAR) 25.1309 and 25.581. These FARs are intended for transport aircraft, but there are equivalent sections for general aviation aircraft, normal and transport rotorcraft. Military aircraft may have additional requirements. The criteria for demonstration of adequate lightning protection for a FADEC systems include the procedures outlined in FAA Advisory Circular (AC) 20-136, Protection of aircraft electrical/electronic systems against the indirect effects of lightning. As FADEC systems, including the interconnecting wiring, are generally not susceptible to direct attachment of lightning currents, the verification of protection against indirect effects is primarily described. Author

AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A91-53556

FLIGHT CONTROL ACTUATION SYSTEM FOR THE B-2
ADVANCED TECHNOLOGY BOMBER

W. S. SCHAEFER (Moog, Inc., East Aurora, NY), L. J. INDERHEES, and J. F. MOYNES (Northrop Corp., Pico Rivera, CA) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 14 p. (SAE PAPER 911112) Copyright

The B-2 Advanced Technology Bomber has a very unconventional shape and unique requirements to fulfill its mission. In order to satisfy the demanding requirements for the B-2's excellent handling qualities a flight control system was developed with unrivaled performance and sophistication. A key subsystem of the flight control system is the Flight Control Actuation System (FCAS). The FCAS is a self-contained quadruplex system that includes hydraulic actuators with direct drive servovalves for all surfaces, electronic actuator loop closures, and redundancy management. Author

A91-53741*# National Aeronautics and Space Administration.
 Langley Research Center, Hampton, VA.

TAIL VENTING FOR ENHANCED YAW DAMPING AT
SPINNING CONDITIONS

H. P. STOUGH, III, RAYMOND D. WHIPPLE (NASA, Langley Research Center, Hampton, VA), and C. M. FREMAUX (Lockheed Engineering and Sciences Co., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 144-151. refs (AIAA PAPER 91-3220) Copyright

An investigation was conducted in the NASA Langley 20-ft Vertical Spin Tunnel to determine the spin and spin-recovery characteristics of a 1/11-scale model of a low-wing general aviation airplane with a horizontal tail modified with variable-size gaps to allow ventilation of the vertical stabilizer and rudder. Erect spins at symmetric loadings were tested with varying gap sizes on either or both sides of the horizontal tail. The model results indicate that the basic airplane (with no gaps) exhibits a fast, flat spin from which no recoveries can be obtained. The airplane with the modified tail has either a fast, flat spin from which no recoveries or poor recoveries may be made, or a slower, steeper spin from which fair to excellent recoveries may be obtained, depending on the size and orientation of the tail gaps. The major contribution to spin recovery was from the gap on the leeward side of the tail. Gap widths of 15-25 percent of the tail semispan were needed to produce satisfactory recovery from the flat spin. Author

A91-54020#

DEVELOPMENT OF GENERIC HELICOPTER PERFORMANCE
EQUATIONS AND METHODOLOGY

KAYDON A. STANZIONE and RANDALL F. SMITH (Praxis Technologies Corp., Woodbury, NJ) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3095) Copyright

An analytical method, developed for estimating mission performance for generic single rotor helicopter configurations is presented. This method is based on a semiempirical helicopter rotor theory, utilizing flight test data available from the literature. Mathematical reduction techniques are described to develop a single equation that offers a continuous and smooth curve fit defining power required from hover to dash airspeed for any operating condition. This approach to helicopter performance

prediction is incorporated in a mission performance and planning system that is compact in size and computationally efficient.

R.E.P.

A91-54031#

FLIGHT DEMONSTRATION OF THE SELF-REPAIRING FLIGHT CONTROL SYSTEM IN A NASA F-15 AIRCRAFT

JAMES M. URNES (McDonnell Aircraft Co., Saint Louis, MO) and ROBERT B. YEAGER (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 10 p. (AIAA PAPER 91-3106) Copyright

The Self-Repairing Flight Control System includes onboard maintenance diagnostics and control-system reconfiguration for conditions of damaged control surfaces. A proof-of-concept flight test/demonstration was accomplished on an F-15 test airplane at NASA Dryden, Edwards AFB, California. Flight testing was performed over a four-month period, and 25 flights were flown. Flight testing of the onboard maintenance-diagnostics system consisted of evaluating six emulated faults. These faults demonstrated the capability of the rule-based expert system to isolate intermittent LRU failures of mechanical, electrical or hydraulic origin. These failures represent the type of maneuver-related faults that are difficult to detect during post-flight maintenance, causing cannot-duplicate events and excessive aircraft downtime. Flight testing of real-time control reconfiguration consisted of obtaining flying qualities for: (1) an unimpaired airplane, (2) an airplane with an emulated failure but without reconfiguration of the control system, and (3) an emulated fault compensated by reconfiguration. Faults emulated were an 80-percent-missing right stabilator and stuck stabilator conditions. Author

A91-54032*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DESIGN AND PILOTED SIMULATION EVALUATION OF INTEGRATED FLIGHT/PROPULSION CONTROLS FOR STOVL AIRCRAFT

JAMES A. FRANKLIN and SHAWN A. ENGELLAND (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3108) Copyright

Integrated flight/propulsion control systems have been designed for operation of STOVL aircraft over the low speed powered-lift flight envelope. The control system employs command modes for attitude, flightpath angle and flightpath acceleration during transition, and translational velocity command for hover and vertical landing. The command modes and feedback control are implemented in the form of a state-rate feedback implicit model follower to achieve the desired flying qualities and to suppress the effects of external disturbances and variations in the aircraft characteristics over the low speed envelope. A nonlinear inverse system was used to translate the output from these commands and feedback control into commands for the various aerodynamic and propulsion control effectors that are employed in powered-lift flight. Piloted evaluations of these STOVL integrated control designs have been conducted on Ames Research Center's Vertical Motion Simulator to assess flying qualities over the low-speed flight envelope. Results indicate that Level 1 flying qualities are achieved with this control system concept for each of these low-speed operations over a wide range of wind, atmospheric turbulence, and visibility conditions. Author

A91-54034#

APPLICATION OF LQG/LTR DESIGN TECHNIQUE TO AIRCRAFT STABILIZATION AND CONTROL USING NOVEL FEEDBACK PARAMETERS

MARSHALL S. HYNES and JOHN W. CLARK, JR. (U.S. Navy, Naval Air Development Center, Warminster, PA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs (AIAA PAPER 91-3110)

An exploratory development program was conducted to identify

a viable feedback strategy for satisfactory stability and control of an advanced fighter-type aircraft that does not employ aerodynamic angle-of-attack (AOA) and angle-of-sideslip (AOS) feedback. A modern control design approach was selected to develop the control laws required to provide satisfactory stability, flying qualities, and turbulence-suppression characteristics with feedbacks other than AOA or AOS. The LQG/LTR design technique was able to satisfy the design objectives for the cases tested, often at the expense of high control energy. LQG/LTR solves the 'cheap-control' minimization problem so control magnitude or rate saturation was always a concern. The best response characteristics were achieved when the feedback control law structure consisted of a complementary filter blend of angle of attack derived from the normal acceleration and inertial vertical velocity. Good command-following and turbulence-rejection characteristics dictated a high low-frequency gain (or high bandwidth) system design. Pilot-in-the-loop simulation is planned to quantify the flying qualities of the closed-loop designs. Author

A91-54035*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DESIGN OF AN ACTIVE FLUTTER SUPPRESSION SYSTEM FOR THE ACTIVE FLEXIBLE WING

MARTIN R. WASZAK and CAREY S. BUTTRILL (NASA, Langley Research Center, Hampton, VA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3111) Copyright

The design of an active flutter suppression controller and wind tunnel validation test results are presented. This controller, designed using Nyquist methods and traditional root locus, is applied to the Active Flexible Wing (AFW) wind tunnel model. Wind tunnel tests were conducted to validate the design and demonstrate flutter suppression at a fixed altitude while performing aggressive rolling maneuvers representative of high-performance military aircraft. The controller succeeded in simultaneous suppression of two distinct flutter modes by significantly increasing the flutter dynamic pressure in spite of errors in the mathematical model. R.E.P.

A91-54082#

POST-STALL MANEUVER AND THE CLASSIC TURN RATE PLOT

DANIEL P. RAYMER (Conceptual Research Corp., Sylmar, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. refs (AIAA PAPER 91-3170) Copyright

Vectored thrust turning and post-stall maneuver (PSM) are defined in terms of the classic turn rate maneuver. Thrust is utilized for turning, low speed allows smaller turn radii and greater thrust-induced turn rate, and dynamic pitch-up is momentarily employed to place the nose on target. Of the options for thrust vectoring, the vectoring nozzles at the center of gravity provide the greatest turn rate and operational flexibility, including the ability to vector forward for deceleration. It is shown that PSM and thrust-induced turning are not in conflict with the classic turn rate plot. R.E.P.

A91-54084#

LONGITUDINAL AND DIRECTIONAL STATIC STABILITY EFFECTS OF A LARGE RADOME MOUNTED ATOP A 747-200 AIRCRAFT

WAYNE E. FRAZIER (E-Systems, Inc., Greenville, TX) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 10 p. (AIAA PAPER 91-3173)

This paper presents the results of a wind tunnel investigation into the longitudinal and directional static stability effects of a large radome mounted atop a 747-200 aircraft. Radome incidence and fineness ratio (length/thickness) are examined. Additional modifications are considered in the form of a canard and horizontal tail endplates. Effects of the modifications are compared to the unmodified aircraft. The advanced surveillance and tracking

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technology design concept is found to be aerodynamically acceptable from a static stability viewpoint. The wind tunnel test data indicate that the higher fineness ratio (10.49) radome at the 3-deg incidence is found to be the preferred configuration. Cruise shows reductions from 20 percent at Mach 0.6 to 30 percent at Mach 0.7. None of the results exhibit an unstable condition.

C.A.B.

A91-54091* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EVALUATION OF THE LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A MIXED-FLOW REMOTE-LIFT STOVL AIRCRAFT IN TRANSITION AND HOVER

SHAWN A. ENGELLAND (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs

(AIAA PAPER 91-3185) Copyright

An evaluation of the longitudinal stability and control characteristics of a mixed-flow remote-lift (MFRL) STOVL aircraft in the powered-lift portion of the flight envelope is presented. A stabilization and command augmentation system was implemented on the MFRL aircraft to meet the requirements for satisfactory flying qualities. The pitch portion of this control system uses a state-rate feedback implicit model following controller to achieve the desired flying qualities and to suppress the effects of external variations and disturbances in the aircrafts characteristics over the low speed envelope.

R.E.P.

A91-54448

FLIGHT QUALITY CRITERIA AND LONG-TERM DYNAMICS IN SUPERSONIC AND HYPERSONIC FLIGHT [FLUGEIGENSCHAFTSKRITERIEN UND LANGZEIT-DYNAMIK IM UEBERSCHALL- UND HYPERSCHALLFLUG]

G. SACHS (Muenchen, Technische Universitaet, Munich, Federal Republic of Germany) Zeitschrift fuer Flugwissenschaften und Weltraumforschung (ISSN 0342-068X), vol. 15, Aug. 1991, p. 243-251. In German. refs

(Contract DFG-SFB-255)

Copyright

The flight mechanical characteristics of the long-term dynamics in supersonic and hypersonic flight and their effects on flight quality requirements and guidelines are studied. It is shown that similar flight-mechanical relations exist for both Mach number regimes with regard to modes of motion and long-term stability as well as response qualities of the aircraft. It is shown that the treatment of flight quality requirements relates to the stability of the long-term dynamics under special conditions of periodic instabilities and using related flight test methods. Discrepancies are pointed out and a new flight quality requirement involving the correlation between velocity and pitch attitude is considered. It is shown that the classical relation which exist in the subsonic regime do not apply to the supersonic and hypersonic regimes.

C.D.

A91-54577* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

VALIDATION OF THE F-18 HIGH ALPHA RESEARCH VEHICLE FLIGHT CONTROL AND AVIONICS SYSTEMS MODIFICATIONS

VINCE CHACON, JOSEPH W. PAHLE, and VICTORIA A. REGENIE (NASA, Flight Research Center, Edwards, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 1-10. Previously announced in STAR as N90-28542. refs

The verification and validation process is a critical portion of the development of a flight system. Verification, the steps taken to assure the system meets the design specification, has become a reasonably understood and straightforward process. Validation is the method used to ensure that the system design meets the needs of the project. As systems become more integrated and more critical in their functions, the validation process becomes

more complex and important. The tests, tools, and techniques which are being used for the validation of the high alpha research vehicle (HARV) turning valve control system (TVCS) are discussed, and their solutions are documented. The emphasis of this paper is on the validation of integrated systems.

Author

A91-54606

DESIGN OF A LOW COST, FAULT TOLERANT FLIGHT MANAGEMENT AND CONTROL SYSTEM FOR GENERAL AVIATION AIRCRAFT

DAVID ROBB (ReSound Corp., Redwood City, CA) and JON PLATT (Vasamedic Corp., Bloomington, MN) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 212-217. refs

Copyright

A design for a fully integrated flight management/flight control system suitable for light aircraft is introduced. The goals of the system are discussed, and a top-level design to meet those goals is outlined. Tradeoffs among selected elements are discussed, and performance issues are considered. The overall goals of the system are increased flight safety with a reduction of general pilot skill requirements. These goals will be accomplished by workload reduction, uniform data presentation, a natural user interface to flight data and controls, active flight condition monitoring and assistance, and active flight controls. Low cost will be attained by use of readily available industrial components. System reliability will be ensured by careful design and use of redundant elements to avoid single-point critical failures. Active flight assistance will reduce the skill necessary for safe aircraft operation. Deabstraction and appropriate presentation of data, particularly navigation and systems data, will greatly reduce the pilot workload and contribute to flight safety and enjoyment.

I.E.

A91-54610* National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

FLIGHT CONTROL SYSTEM DESIGN FACTORS FOR APPLYING AUTOMATED TESTING TECHNIQUES

JOEL R. SITZ (NASA, Flight Research Center, Edwards, CA) and TODD H. VERNON (Planning Research Corp., Edwards, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 235-247. refs

Copyright

The principal design features and operational experiences of the X-29 forward-swept-wing aircraft and F-18 high alpha research vehicle (HARV) automated test systems are discussed. It is noted that operational experiences in developing and using these automated testing techniques have highlighted the need for incorporating target system features to improve testability. Improved target system testability can be accomplished with the addition of nonreal-time and real-time features. Online access to target system implementation details, unobtrusive real-time access to internal user-selectable variables, and proper software instrumentation are all desirable features of the target system. Also, test system and target system design issues must be addressed during the early stages of the target system development. Processing speeds of up to 20 million instructions/s and the development of high-bandwidth reflective memory systems have improved the ability to integrate the target system and test system for the application of automated testing techniques. It is concluded that new methods of designing testability into the target systems are required.

I.E.

A91-54673

CERTIFICATION OF AN AIRBORNE DIGITAL FLIGHT MANUAL FOR THE GULFSTREAM IV

STEVEN C. RUNO and MICHAEL J. WILLIAMS (Honeywell, Inc., Business and Commuter Aviation Systems Div., Glendale, AZ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p.

610-615. refs

Copyright

In February 1990, the Gulfstream IV (G-IV) received FAA certification of the first complete airborne, digital FAA-approved airplane flight manual (AFM). The full AFM takeoff and landing computations are provided by the Honeywell PZ-800 Performance/Autothrottle Computer. The computations extend far beyond Quick Reference Handbook (QRH) estimates found on the most advanced air transport aircraft. The PZ-800 predictions include the following for both full-rated and reduced-thrust takeoffs: *AVspeeds* (decision speed, rotation speed, second-segment speed, final segment speed, single-engine speed, and landing flaps reference speed) and distances (accelerate-stop, accelerate-go, and required field length). Landing computations also include speeds, distances and engine-settings. This system represents the first airborne application of a full digital flight manual. Approval of the PZ-800 takeoff and landing functions faced several certification and technical challenges. These challenges, as well as operation, design features, and testing of the PZ-800, are discussed. I.E.

A91-55034

AIRCRAFT HEAVE-PITCH DYNAMICS TO TRACK INDUCED EXCITATION

D. YADAV (Indian Institute of Technology, Kanpur, India) and R. P. RAMAMOORTHY Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, Feb. 1991, p. 19-28. refs

The aircraft heave-pitch track-induced dynamics was analyzed with a heave-pitch model having an articulated nose gear and telescopic main gear. The formulation incorporates the effects of linkage dynamics as well as nonlinearities in the air spring, hydraulic force, tire spring, and sliding friction. The dynamic response of the model was developed over an uneven track profile that was assumed to be made up of a zero mean random roughness superimposed on a variable mean level. Results were obtained by simulating the track profile through filtering of a Gaussian sequence. It was found that the controlling factor for mean response was the track mean profile, while the response standard deviation was primarily governed by the track variance. I.S.

A91-55040

A SYNTHESIS OF REDUCED-ORDER COMPENSATORS FOR ACTIVE FLUTTER SUPPRESSION SYSTEM BASED ON THE OPTIMAL PROJECTION METHOD

ATSUSHI FUJIMORI Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 440, 1990, p. 476-483. In Japanese. refs

A synthesis of reduced-order compensators for active flutter suppression of a 2D airfoil is studied using the optimal projection method. In the method, condition for minimizing a quadratic performance index is taken into consideration for a compensator whose order is less than the order of the controlled plant. A reduced-order compensator is then constructed by satisfying the condition. In this paper, rough derivation of two modified Riccati equations and two modified Liapunov equations as the condition are shown. Since these equations are coupled to each other, it is not possible to solve them at one time. Therefore, iterative calculation methods are examined and an algorithm which improves a defect of the existing iterative method is proposed. Numerical simulations which are carried out using thirteenth-order active flutter suppression systems of a two-dimensional airfoil show that the optimal projection method can yield second-order compensators in all simulation cases, and compensators whose order is six or more almost show the same control performance as the optimal observer, that is, Kalman filter. Author

A91-55042

GIVEN FLIGHT TRAJECTORY CONTROLLER FOR AIRCRAFT YORIAKI BABA and SEIZI MIYAMOTO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 440, 1990, p. 494-501. In Japanese. refs

In this paper, the synthesis of nonlinear flight control system for an aircraft to track a given trajectory is presented. The trajectory is given in the form of position in space, which are the functions

of time or the tangent velocity and the two path angles which are computed from the differentiation of the position with respect to time. The forces which guide the airplane along the given trajectory are basically constructed of two parts. One is the force necessary for the program motion and the other is the force to eliminate the guidance errors. The algorithm of this controller was applied to an F-4 fighter performing a barrel roll maneuver and some numerical simulations were performed. The results showed that the differences between the actual flight path and the given one were negligible. Author

A91-56454

ANALYSIS ON DESIGN CHARACTERISTIC AND KEY TECHNIQUES OF A CERTAIN TYPE OF SUPER-LOW ALTITUDE PILOTLESS AIRCRAFT

ZHENGRONG XU (Research Institute of Pilotless Aircraft, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 23, Sept. 1991, p. 69-78. In Chinese. refs

This paper mainly expounds the design characteristics and key techniques of a certain type of super-low altitude pilotless aircraft. First, the environmental conditions of the super-low altitude flight, such as increasing dynamic pressure, aggravating atmospheric turbulence, difficulty in radar tracking and interfering in telemetry/remote control/location are analyzed. Second, this paper analyzed and calculated the dynamic response of atmospheric turbulence for the different modified program of prototype at different M and H. On the basis of these, in order to decide what measures are adopted to relax transition process, alleviate gust response, improve flight quality, enhance precision of flight, avoid touching ground and ensure safety, thus guaranteeing the tactical-technical requirements and norms, completing the selection of the aerodynamic layout, the design and calculation of the flight path, the design of the flight control system and the choosing of parameters, structural analysis and design, and comprehensive test demonstration. Scientific research on flight test demonstration and the finalized design flight appraisal for this pilotless aircraft have been successfully completed. Author

N91-31184# Societe de Fabrication d'Instruments de Mesure, Massy (France).

ROBUSTNESS AND TECHNIQUES OF MULTIVARIABLE CONTROL FOR HELICOPTER PILOTING. DISPATCH 3: INCLUSION REGIONS TECHNIQUE ON LINEAR MODEL [ROBUSTESSE ET TECHNIQUES DE COMMANDE MULTIVARIABLE POUR LE PILOTAGE DE L'HELICOPTERE. LOT 3: TECHNIQUE DES REGIONS D'INCLUSION SUR MODELE LINEAIRE]

29 Aug. 1990 84 p In FRENCH (RD/PA-14-227; ETN-91-99975) Avail: NTIS HC/MF A05

The inclusion regions method is applied to the basic stability design of an automatic helicopter pilot. The basis of an inclusion regions approach is the localization of real values of a perturbed system from a nominal system. Two types of regions are distinguished: robust but conservative regions obtained by normal approximations; E contours, which are fields obtained from the so-called real values of the nominal system and the size of perturbation. Techniques to reduce the extent of these regions at a given frequency are studied. Problems using the method with prohibitively sized perturbations are discussed. ESA

N91-32142# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.). Abt. Stabilitaet und Antwort.

AEROELASTIC FLUTTER PREVENTION IN GLIDERS AND SMALL AIRCRAFT

WALTER STENDER and FRITZ KIESSLING Sep. 1990 64 p (DLR-MITT-91-03; ISSN-0176-7739; ETN-91-90031) Avail: NTIS HC/MF A04; DLR, Wissenschaftliches Berichtswesen, VB PL DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 15 DM

An empirical method which can be used by the manufacturers of gliders and small aircraft to evaluate flutter vulnerability without

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extensive computational analysis and to take appropriate preventive measures is specified. Suggestions on how designers can avert flutter from the very outset of the design process are given. This method was applied in numerous cases and can be considered proven for conventional structures. It is based on the results of a simple vibration test as well as stiffness and friction measurements taken on the control system. Statistically derived design frequencies are given, thus restricting the number of vibration modes which must be considered. Through this method the required mass balance for the control surfaces is derived. Simple formulas for the calculation of the torsion frequency and the critical speed for torsional flutter are given. ESA

N91-32143*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

APPLICATION OF AN INTEGRATED FLIGHT/PROPULSION CONTROL DESIGN METHODOLOGY TO A STOVL AIRCRAFT
SANJAY GARG and DUANE L. MATTERN (Sverdrup Technology, Inc., Brook Park, OH.) 1991 12 p Presented at the Guidance, Navigation and Control Conference, New Orleans, LA, 12-14 Aug. 1991; sponsored by AIAA Previously announced in IAA as A91-49793
(NASA-TM-105254; E-6583; NAS 1.15:105254; AIAA-91-2792)
Avail: NTIS HC/MF A03 CSCL 01/3

Results are presented from the application of an emerging Integrated Flight/Propulsion Control (IFPC) design methodology to a Short Take Off and Vertical Landing (STOVL) aircraft in transition flight. The steps in the methodology consist of designing command shaping prefilters to provide the overall desired response to pilot command inputs. A previously designed centralized controller is first validated for the integrated airframe/engine plant used. This integrated plant is derived from a different model of the engine subsystem than the one used for the centralized controller design. The centralized controller is then partitioned in a decentralized, hierarchical structure comprising of airframe lateral and longitudinal subcontrollers and an engine subcontroller. Command shaping prefilters from the pilot control effector inputs are then designed and time histories of the closed loop IFPC system response to simulated pilot commands are compared to desired responses based on handling qualities requirements. Finally, the propulsion system safety and nonlinear limited protection logic is wrapped around the engine subcontroller and the response of the closed loop integrated system is evaluated for transients that encounter the propulsion surge margin limit.

Author

N91-32145*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DEVELOPMENT AND EVALUATION OF AN INVERSE SOLUTION TECHNIQUE FOR STUDYING HELICOPTER MANEUVERABILITY AND AGILITY

MATTHEW S. WHALLEY Jul. 1991 55 p
(NASA-TM-102889; A-91020; NAS 1.15:102889;
USAAVSCOM-TR-90-A-008) Avail: NTIS HC/MF A04 CSCL 01/3

An inverse solution technique for determining the maximum maneuvering performance of a helicopter using smooth, pilotlike control inputs is presented. Also described is a pilot simulation experiment performed to investigate the accuracy of the solution resulting from this technique. The maneuverability and agility capability of the helicopter math model was varied by varying the pitch and roll damping, the maximum pitch and roll rate, and the maximum load-factor capability. Three maneuvers were investigated: a 180-deg turn, a longitudinal pop-up, and a lateral jink. The inverse solution technique yielded accurate predictions of pilot-in-the-loop maneuvering performance for two of the three maneuvers. Author

N91-32146# Aeronautical Research Labs., Melbourne (Australia).

TIME-FREQUENCY DOMAIN ANALYSIS OF HELICOPTER TRANSMISSION VIBRATION

B. D. FORRESTER Aug. 1991 37 p Original contains color

illustrations

(ARL-PROP-R-180; AR-005-606) Copyright Avail: NTIS HC/MF A03

Vibration analysis is playing an increasingly important role in the early detection of helicopter transmission faults. Current vibration analysis techniques used in helicopter transmission fault detection require selective filtering or manipulation of the signal, based on assumptions about the nature of the signal. In some cases these techniques can give misleading results. It is shown that the application of time-frequency domain representations, based on the Wigner-Ville distribution, is capable of detecting a variety of vibration features which can be used to classify faults.

Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A91-53564

AUTOMOTIVE/AEROSPACE SYNERGISM THROUGH OPTIMUM SELECTION/USE OF GROUND SUPPORT EQUIPMENT (GSE)

PAUL D. TUCK SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 18 p. refs
(SAE PAPER 911122) Copyright

This paper demonstrates and sheds light on the fact that optimum selection and use of a judicious mix of ground-support equipment, rather than a single piece of equipment (like a Super Loader), has a synergistic effect on overall efficiency and productivity. The paper also deals with a conceptual aircraft cargo loader referred to as the super loader. The loader may be described as a self-propelled air transportable (in a C-141, C-17, or C-5) 60,000-lb lifting capacity, adjustable-height vehicle that can on/off-load all transport aircraft from a C-130, whose cargo deck is only 3 feet, 3 inches high to a B-747 whose main deck upper limit is about 18 feet high.

Author

A91-53757#

DETERMINATION OF DYNAMIC STABILITY PARAMETERS IN A LOW SPEED WIND TUNNEL

G. GUGLIERI (CNR, Turin, Italy) and F. B. QUAGLIOTTI (Torino, Politecnico, Turin, Italy) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 328-336. refs
(AIAA PAPER 91-3245) Copyright

An experimental program was initiated to investigate the behavior of aircraft at high angles of attack. The program involves both wind tunnel tests for the evaluation of the dynamic stability parameters and the development of mathematical models. The discussion covers a description of the wind tunnel, model, mechanical rig and control unit, and data acquisition system. Some experimental results are presented which relate mostly to an evaluation of the damping derivatives.

V.L.

A91-53769*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

AN EFFICIENT SUPERSONIC WIND TUNNEL DRIVE SYSTEM FOR MACH 2.5 FLOWS

STEPHEN W. D. WOLF, JAMES A. LAUB, and LYNDALL S. KING (NASA, Ames Research Center, Moffett Field, CA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 461-471. refs
(AIAA PAPER 91-3260)

A novel efficient drive system has been developed which

provides for the continuous operation of a pitot Mach 2.5 wind tunnel at compression ratios down to 0.625:1. The drive system does not require an overpressure to start, and no hysteresis has been observed. The general design of the proof-of-concept wind tunnel using the new drive system and its modifications are described. V.L.

A91-53866* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EVALUATION OF TUNNEL SIDEWALL BOUNDARY-LAYER-CONTROL SYSTEMS FOR HIGH-LIFT AIRFOIL TESTING

K. PASCHAL, W. GOODMAN, R. MCGHEE, B. WALKER (NASA, Langley Research Center, Hampton, VA), and PETER A. WILCOX (Douglas Aircraft Co., Long Beach, CA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 14 p. refs

(AIAA PAPER 91-3243) Copyright

An experimental study was conducted in the NASA Langley Low-Turbulence Pressure Tunnel to evaluate a suction sidewall boundary-layer-control (BLC) technique used in testing 2D high-lift airfoils. Sidewall BLC is required to maintain spanwise two-dimensionality of the flow over the airfoil at large angles of attack. A supercritical-type high-lift air-foil, equipped with a double-slotted flap and a leading-edge slat, was used for the study which was conducted at a Mach number of 0.2 and Reynolds numbers based on chord of 9 and 16 million. The sidewall BLC technique, which features distributed suction through porous endplates connected to a venting system, was able to control sidewall boundary-layer separation and maintain two-dimensional flow over the high-lift configuration for both Reynolds numbers tested. Discussions on porous endplate optimization and effects of suction on section lift are presented. Results obtained with the suction system were also compared with previous data obtained with a tangential blowing BLC system for the same high-lift configuration. Author

A91-53995 TAILORING A TEMPERATURE-ALTITUDE-HUMIDITY TEST BASED ON AIRCRAFT MISSION PROFILES

HANK CARUSO (Westinghouse Electric Corp., Product Qualification Laboratory, Baltimore, MD) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 558-567. refs

Copyright

This paper describes and applies a three-step process for translating aircraft mission profiles into practical laboratory temperature-altitude-humidity tests. First, environmental conditions associated with mission scenarios (Mach number/altitude time histories) are identified. Second, these conditions are converted to profiles that could be performed in an 'ideal' test chamber with no practical operating restrictions. Third, the ideal test profiles are converted to profiles that can be performed practically and efficiently with existing facilities. The resulting profile has the same significant stress conditions present as would be expected in mission use. An example of this process is included. Author

A91-54060# MAN-IN-THE-LOOP SIMULATION AS A VTOL DEVELOPMENT TOOL

G. W. LIND and V. BECK (Grumman Corp., Aircraft Systems Div., Bethpage, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p. refs

(AIAA PAPER 91-3144) Copyright

The use of a man-in-the-loop simulator is considered as part of the preliminary design process of a flexible VTOL vehicle which utilizes a low-speed fan-in-wing concept. Several pilots test the concept in a simulator to examine the controllers and functions as well as the flight control modes of operation. The control options include lateral speed/position, roll, and altitude as well as

longitudinal speed/position and pitch, and the simulation results permit the design to address aircraft combat requirements as identified by the pilots. C.C.S.

A91-54644

MIL-STD-1553 VALIDATION AND TEST FACILITY

JORGE RIVERA (U.S. Army, Aviation Systems Command, Saint Louis, MO), DOUGLAS S. D'AVINO, and CHRIS DELONG IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 436-440.

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The US Army Aviation Systems Command's (AVSCOM) Directorate for Life Cycle Software Engineering (DLCSE) has recently taken action to provide facilities (both laboratory and portable) for the independent assessment, verification and validation, and testing of MIL-STD-1553 subsystems. The DLCSE facility provides direct linkage from the subsystem Multiplex Interface Control Document (MICD) through real-time testing for the subsystem over a MIL-STD-1553 data bus. In addition, the MICD is provided in an electronic format. An overview of the facility capabilities is given as well as a detailed analysis of the results of validation and testing of remote terminals developed for Army and tri-service programs. In addition, the tri-service program to extend this facility to other data bus programs are described. I.E.

A91-54714

THE ADVANCED GROUND STATION

TIM SMITH (GEC Avionics, Ltd., Rochester, England) IN: Remotely piloted vehicles; International Conference, 8th, Bristol, England, Apr. 2-4, 1990, Proceedings. Bristol, England, University of Bristol, 1990, p. 17.1-17.15.

Copyright

A review is presented of the remotely piloted aerial target ground control facility currently operating at Cardigan Bay, U.K. Attention is focused on the development of an advanced state-of-the-art system that is being operationally tested as a replacement for RPV control and total RPV systems. Consideration is given to the advanced ground station system, hardware and software, graphics display system and interface, remote sites and selection control, and radar, command and telemetry processing. R.E.P.

A91-55038

ROCKET SLED FACILITY AND ITS USE IN PERFORMANCE EVALUATION OF PARACHUTES

J. K. TYAGI and PARAG KUMAR (Aerial Delivery Research and Development Establishment, Agra, India) Aeronautical Society of India, Journal (ISSN 0001-9267), vol. 43, Feb. 1991, p. 49-54. refs

The Indian Rail Track Rocket Sled (RTRS) facility built for testing new parachute systems is described. The RTRS uses a rocket-powered trolley moving on a rail track, referred as 'sled' because its interface with the rails consists of steel shoes which are in sliding contact with the rails; the parachute is packet inside a metallic container which is mounted on the top plate of the sled. The deployment of the parachute is initiated by firing the explosive bolt holding the lid of the container. As the lid goes off, the spring of the pilot chute retracts and the pilot chute comes out, pulling out the main parachute and deploying the total system. Details are given for tests performed on a unicross-design brake parachute for a combat aircraft. I.S.

A91-55609

CRYOGENIC TRANSONIC WIND TUNNELS AND THE CONDENSATION OF NITROGEN

P. P. WEGENER (Yale University, New Haven, CT) Experiments in Fluids (ISSN 0723-4864), vol. 11, no. 5, Sept. 1991, p. 333-338. refs

Copyright

A brief tutorial on the need for Reynolds number similarity and the advent of cryogenic transonic wind tunnels is presented.

09 RESEARCH AND SUPPORT FACILITIES (AIR)

Experimental results of nitrogen condensation in nozzles are collected and related to the flow in the wind tunnels. New theoretical approaches to a solution of the condensation problem in the super-saturated state are proposed. Author

A91-56125

AEROTHERMODYNAMIC DESIGN OF NOISE SUPPRESSORS FOR GROUND RUNNING OF AFTERBURNING ENGINES

S. A. FISHER and A. M. ABDEL-FATTAH (Defence Science and Technology Organisation, Aeronautical Research Laboratory, Melbourne, Australia) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 249-257. Previously announced in STAR as N91-22136. refs

Copyright

Upgraded facilities for ground running of F404 engines in F/A-18 aircraft at RAAF Williamtown will feature air-cooled exhaust augmentors for noise suppression. Aerothermodynamic aspects of the augmentor designs were appraised in some detail, making use of isothermal scale model tests, ejector theory, and available empirical data. In initial design development, quantitative assessments were made of cooling flow pumping performance. Changes were recommended to improve the aerodynamic characteristics of the exhaust augmentors and eliminate high risk features, and the sizes of the augmentor ducts were significantly reduced. The model tests identified certain geometric features which were important for symmetry of the flow in the augmentor ducts and to pumping performance. Once modified accordingly, the designs displayed satisfactory aerodynamic behavior, which was tolerant to both inlet asymmetries and reasonable levels of engine jet misalignment. The pumping performance was shown to exceed the design requirements. Author

A91-56138

VALIDATION RIG - A TOOL FOR FLAME STUDIES

A. SJUNNESSON, S. OLOVSSON, and B. SJOBLOM (Volvo Flygmotor, AB, Trollhattan, Sweden) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 385-393. Research supported by STU, Defense Materiel Administration of Sweden, Volvo Flygmotor, AB, et al. refs

Copyright

A flexible modular combustor with optical access has been developed to generate experimental data for model validation. It was designed to enable the use of non-intrusive optical measurement techniques and to allow various combustion systems to be studied in an idealized fashion. The present paper describes the initial tests of lean blowout, combustion stability and local gas analysis measurements performed in a propane-air flame with three different bluff body flameholders. Computer simulations of a premixed flame using a standard finite difference code has been carried out and the results are compared with gas analysis. Improved results were obtained using modified values of the Magnussen constants in the combustion model. Author

A91-56182

A TEST FACILITY FOR THE STUDY OF THE THERMOFLUID-DYNAMICS OF GAS BEARING LUBRICATION FILMS

S. I. HOGG, S. J. HUGHES, and T. V. JONES (Oxford, University, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 771-779. Research supported by SERC and Rolls-Royce, PLC. refs

Copyright

A novel test facility for fundamental investigations of hydrodynamic gas bearing lubrication films is described. The need for this experiment is discussed in the context of previous studies, and the design and manufacture of the facility is described in detail. Some interesting test results for a hydrostatic thrust bearing

are described which were obtained while commissioning the facility. These results are compared with numerical simulations obtained by solving the Reynolds equation. Author

A91-56192

A TRI-SONIC CASCADE TUNNEL

H. V. HATTINGH, T. W. VON BACKSTROM, J. S. VAN WYK, and C. H. H. FRAUENSTEIN (Bureau for Mechanical Engineering, Inc., Stellenbosch, Republic of South Africa) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 867-873. refs

Copyright

The design and construction is described of a wind tunnel for testing turbine and compressor cascades at sub-, trans- and supersonic inlet velocities. The tunnel is driven by compressed air supplied to its inlet settling chamber or, with the settling chamber open to atmosphere, to an ejector downstream of the tunnel's discharge plenum chamber. Author

A91-56369

VORTEX LATTICE CODE FOR COMPUTATION OF WIND TUNNEL AND SUPPORT EFFECTS ON MODELS

X. VAUCHERET (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 2, 1991, p. 39-51. Research supported by Service Technique des Programmes Aeronautiques. refs

Copyright

To eliminate the assumptions inherent in the analytical method employed to obtain the wall and model support effects in the wind tunnel, a new computation code based on the vortex lattice procedure is developed. This code can process the case of noncylindrical test sections with any shape which may or may not have local perforated areas whose pressure loss characteristics may be nonlinear. The effects of supports with an arbitrary shape may be considered, after meshing, by integrating the matrix of test section wall mesh cells. R.E.P.

A91-56539

AUTOMATED FATIGUE AND FRACTURE LABORATORY WITH MULTIPLE LOAD FRAMES AND SINGLE HOST COMPUTER SYSTEM

R. SUNDER (National Aeronautical Laboratory, Bangalore, India) IN: Applications of automation technology to fatigue and fracture testing; Proceedings of the Symposium, Kansas City, MO, May 22, 23, 1989. Philadelphia, PA, American Society for Testing and Materials, 1990, p. 232-249. Research sponsored by Aeronautical Development Agency of India. refs

Copyright

An automated fatigue and fracture laboratory was recently set up at the National Aeronautical Laboratory. Six servohydraulic load frames are connected to a single multi-user, time-sharing computer system, through dedicated microprocessor-based interfaces. The host computer system includes resources for post processing of test data, output of test results and their storage and retrieval. Application software was developed for automated crack growth testing under a variety of constant-amplitude and spectrum load test conditions including K-control and on-line fatigue cycle analysis. Automated crack length measurement is through unloading compliance. Author

A91-56628

COMBINED ENVIRONMENTS FACILITY FOR EXTERNALLY CARRIED AIRCRAFT STORES

JAMES RICE (Raytheon Co., Electromagnetic Systems Div., Goleta, CA) (Institute of Environmental Sciences, Annual Technical Meeting, 37th, San Diego, CA, May 1991) IES, Journal (ISSN 1052-2883), vol. 34, Sept.-Oct. 1991, p. 29-33. refs

Copyright

A facility that simulates the environments measured on the AN/ALQ-184 EW Jammer Pod during a series of flight tests is presented. The capabilities of this laboratory, including a discussion of the equipment selection process, and special problems that

had to be addressed are described. The laboratory uses high-intensity acoustic excitation to duplicate the effects of turbulent aerodynamic flow and temperature-conditioned coldplate fluid to create the correct thermal effect on the high voltage section of the pod. R.E.P.

A91-56824

THE CONSTRUCTION AND COMMISSIONING OF A FLEXIBLE WALLED WIND TUNNEL

EWART BRUNDRETT (Waterloo, University, Canada) and PAUL KANKAINEN Canadian Aeronautics and Space Journal (ISSN 0008-2821), vol. 37, Sept. 1991, p. 108-119. Research supported by University of Waterloo. refs

A 610 mm by 910 mm open return wind tunnel has been provided with a test section containing two flexible walls. The original contraction section, fan, and diffusers have been retained. However, the first diffuser performance has been significantly improved by wall jets at the inlet. The new test section has two 610 mm-wide flexible panels constructed from shatter-proof Lexan polycarbonate plastic that form the roof and floor. All experiments and traversing gear are mounted on the side wall sections, and are positioned where required along the test section. The flexible walls have been positioned upstream of a cylinder with nominally 31-percent blockage using ideal flow stream-lines corrected for boundary layer growth. The data, with wall static pressure compensation, give base pressure and drag results in very good agreement with those reported from wind tunnels with very small blockage ratios but which required analytical blockage corrections. Author

N91-31173# Royal Aerospace Establishment, Farnborough (England). Propulsion Dept.

DEVELOPMENTS IN ICING TEST TECHNIQUES FOR AEROSPACE APPLICATIONS IN THE RAE PYESTOCK ALTITUDE TEST FACILITY

M. HOLMES, V. E. W. GARRATT, and R. G. T. DRAGE /n AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 15 p 1990 Copyright Avail: NTIS HC/MF A16; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The altitude test facilities at the Royal Aerospace Establishment at Pyestock are used in support of clearance of aero-engines, intakes, and helicopter rotors to operate under severe icing conditions. An important aspect of the work is the simulation of the wet icing cloud in terms of water concentration, mean droplet size and spectrum. Water spray rakes or booms were developed for this activity and individual nozzles were calibrated in a wind tunnel built for this purpose. A laser particle sizer was used to calibrate typical spray nozzles and attempts were made to establish a traceable standard. The development of cloud simulations is discussed as well as facilities for monitoring ice formation and shedding. Author

N91-31185# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Abt. Systemtechnik und Navigation.

THE EFFECTS OF DIFFERENT SEQUENCING STRATEGIES ON THE CAPACITY OF AIRPORTS

INGRID GERDES Sep. 1990 28 p In GERMAN; ENGLISH summary

(DLR-MITT-90-18; ISSN-0939-298X; ETN-91-99561) Avail: NTIS HC/MF A03; DLR, Wissenschaftliches Berichtswesen, VB-PL-PO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 13 DM

Analytical models for the sequencing problem of a single runway are developed. The model runway capacity is computed for various input data and a sequence length ranging from two to ten aircrafts. The results are discussed. Connections between the theoretical models and the Computer Oriented Metering Planning and Advisory Systems (COMPAS) which includes an algorithm for the planning of sequences are shown. Various Sequencing (SEQ) and Modified Sequencing (MSEQ) processes are developed and compared with

the First Come First Served (FCFS) process. It was established that MSEQ is the best COMPAS approximation. ESA

N91-31186# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).

SIMULATION OF DISTANCE-DEPENDENT FUNCTIONS IN VISUAL SYSTEMS FOR TRAINING SIMULATORS USING THE Z-BUFFER TECHNIQUE

GERHARD BRUNE and WOLFGANG METZE 1990 4 p Presented at the International Training Equipment Conference, Birmingham, England, Apr. 1990 (MBB-UA-1190-90-PUB; OTN-032762; ETN-91-99751) Avail: NTIS HC/MF A01

The use of the z buffer technique to correctly depict mutually occulting objects in the scene is described. The distance information, which is calculated and stored in the z buffer for this purpose, can then be advantageously used to support other range dependent functions of the simulator both within the visual system (simulation of limited visibility, point lights, and its own landing lights) as well as other simulator functions (laser range finder, radar altimeter, and collision detection). ESA

N91-31187# Association Aeronautique et Astronautique de France, Paris.

INSTRUMENTATION UNDER DEVELOPMENT FOR THE ONERA F4 WIND TUNNEL [INSTRUMENTATION EN COURS DE DEVELOPPEMENT POUR LA SOUFFLERIE F4 DE L'ONERA]

A. GIRARD, A. BOUTIER, J. P. CHEVALLIER, and G. FRANCOIS (Office National d'Etudes et de Recherches Aeronautiques, Paris, France) 1989 28 p In FRENCH Presented at the 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A90-19596 (AAAF-NT-89-11; ISBN-2-7170-0944-2; ISSN-0243-0177; ETN-91-99952) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 30 francs

The instrumentation associated to the F4 tunnel is based on: a stioscopic component whose 500 mm diameter mirrors are inside the test chamber emptied before the gust; a six component inertial compensation type balance. The use of a certain number of other techniques is foreseen and particular attention is given to means for studying the effects of real gas. One such technique is electron beam excited fluorescence. Metrological development effort relies equally on holographic interferometry, high cadence infrared thermography, and laser diode spectroscopy. ESA

N91-31188# Association Aeronautique et Astronautique de France, Paris.

A FIRST HOT WIRE SCANNER (UN PREMIER SCANNER A FILS CHAUDS)

J. L. PEUBE and B. NAYROLES (Institut de Mecanique de Grenoble, France) 1989 25 p In FRENCH Presented at 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 (AAAF-NT-89-16; ISBN-2-7170-0949-3; ISSN-0243-0177; ETN-91-99957) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

The question of scanning, to measure a scalar field defined in a continuous medium which occupies a spatial field, is explained. The feasibility of experiments with a hot wire scanner was examined hypothetically at very low frequencies. A simple physical study of the system which validates the hypotheses was carried out. Theoretical comments on resolution algorithm and a numerical exploration of its possibilities for the case of a larger number of wires are presented. Experiments carried out in a wind tunnel with a 12 wire and 9 mesh scanner are described. ESA

N91-31191# Air Force Inst. of Tech., Wright-Patterson AFB, OH.

A KNOWLEDGE-BASE FOR REHABILITATION OF AIRFIELD CONCRETE PAVEMENTS Ph.D. Thesis

09 RESEARCH AND SUPPORT FACILITIES (AIR)

WAYNE J. SEILER 1991 263 p
(AD-A239354; AFIT/CI/CIA-91-004D) Avail: NTIS HC/MF A12
CSCL 01/5

Airfield pavement knowledge captured in this research showed that knowledge-based techniques can be used to quickly select and design rehabilitation alternatives for runways, taxiways or aprons. The AIRfield PAVement Consultant System (AIRPACS) uses the knowledge of planners, constructors, airfield managers and designers to solve difficult jointed plain concrete pavement (JPCP) design problems. This expert system focuses on aircraft safety and pavement structural capacity which are key issues for all pavement design participants. During the validation tests, AIRPACS recommendations were compared to results that were obtained using current empirical and mechanistic design procedures. The results demonstrate that the knowledge acquired and represented in AIRPACS will allow knowledgeable pavement engineers to quickly perform airport rehabilitation designs. GRA

N91-31192# Naval Postgraduate School, Monterey, CA.
TOUCH SCREEN USE ON FLIGHT SIMULATOR
INSTRUCTOR/OPERATOR STATIONS M.S. Thesis
ALAN A. VAZQUEZ Sep. 1990 79 p
(AD-A239524) Avail: NTIS HC/MF A05 CSCL 05/9

The goal was to aid designers in selecting the best data input device for the design of Instructor/Operator Stations (IOSs). A literature review of touch screen, mouse, and trackball technologies is provided. IOS users were surveyed to evaluate the use of touch screens with several military flight simulators. IOS users' experience level, frequency of touch screen interaction, and familiarity with touch screen, mouse, and trackball devices are provided, along with data on the tasks performed, required accuracy, parallax, arm fatigue, and feelings toward touch screen use. It is concluded that, although touch screens are being used by persons with too much experience and for tasks reported in the literature to be inappropriate, results are generally satisfactory. However, it is recommended that input devices should be matched with the tasks performed. GRA

N91-31632*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.
REVIEW OF TYPICAL APPLICATIONS: WIND TUNNELS
JAMES F. MEYERS In VKI, Laser Velocimetry, Volume 2 43 p
1991

Copyright Avail: NTIS HC/MF A10 CSCL 14/2

Laser velocimetry applications to wind tunnels are highlighted. The following are covered: investigation of the flow within a metalorganic chemical vapor deposition reactor; helicopter flow investigations in the 4 by 7 m low speed wind tunnel; boundary layer measurements in a supersonic flow using a laser transit anemometer; basic aerodynamic research tunnel. The future of wind tunnel testing with laser velocimetry. ESA

N91-32039# National Aerospace Lab., Tokyo (Japan).
RAREFIED GAS NUMERICAL WIND TUNNEL 6: DELTA WING
KATSUHIKA KOURA, EMI KANEMATSU, and MIKINARI
TAKAHIRA (Daiko Ltd., Japan) In its Proceedings of the 8th
NAL Symposium on Aircraft Computational Aerodynamics p 49-52
Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

The rarefied gas numerical wind tunnel constructed on the National Aerospace Laboratory Numerical Simulation System with the universal code described using the null-collision direct-simulation Monte Carlo method is used for the simulation of rarefied gas flows around a flat-plate delta wing at a large angle of attack. Some flowfield properties shown by computer graphics are presented. Author

N91-32149*# National Aeronautics and Space Administration.
Langley Research Center, Hampton, VA.
NOZZLE DIFFUSER FOR USE WITH AN OPEN TEST SECTION
OF A WIND TUNNEL Patent Application
P. STEPHEN BARNA, inventor (to NASA) (Barna, P. Stephen,
Consultant, Norfolk, VA) 8 Aug. 1991 16 p

(NASA-CASE-LAR-14424-1-SB; NAS 1.71:LAR-14424-1-SB;
US-PATENT-APPL-SN-743468) Avail: NTIS HC/MF A03 CSCL
14/2

The nozzle diffuser has an inlet in fluid communication with the narrowed inlet of an open test chamber in a conventional wind tunnel. The nozzle diffuser has a passageway extending from its inlet to an outlet in communication with the open test section. The passageway has an internal cross sectional area which increases from its inlet to its outlet and which may be defined by top and bottom isosceles trapezoid walls of a particular flare angle and by isosceles trapezoid side walls of a different flare angle. In addition, a collector having a decreasing internal cross sectional area from inlet to outlet may be provided at the opposite end of the test chamber such that its outlet is in communication with a diffuser located at this outlet. NASA

N91-32628*# Naval Air Test Center, Patuxent River, MD.
Electromagnetic Pulse Section.

ACTIVATION OF THE NAVY'S INDIRECT EFFECTS
LIGHTNING SIMULATION LABORATORY

MIKE WHITAKER In NASA, Kennedy Space Center, The 1991
International Aerospace and Ground Conference on Lightning and
Static Electricity, Volume 1 9 p Aug. 1991
Avail: NTIS HC/MF A99 CSCL 14/2

The Naval Air Test Center is currently the Navy's lead lab for electromagnetic effects testing. As part of this charter, it has been performing lightning effects testing on Navy aircraft in support of specification compliance since 1973. An overview is presented of lightning test and evaluation efforts at NATC, both past and present, as well as its plans for the future. The array of simulation capabilities presently operational are described, and a high level look is given to the test methodology now being used. The principal discussion centers on the results from the recent air launched ordnance test and testing of the Navy's A-6E all weather attack aircraft. Particular attention is paid to the NATC's test approach, including details about coaxial return construction, aircraft preparation, and the test waveforms and data acquisition systems that were used. Author

N91-32700*# Centre d'Etudes de Gramat (France).
A REAL SCALE SIMULATOR FOR HIGH FREQUENCY LEMP
D. GAUTHIER and D. SERAFIN In NASA, Kennedy Space Center,
The 1991 International Aerospace and Ground Conference on
Lightning and Static Electricity, Volume 2 11 p Aug. 1991
Sponsored in part by Direction des Recherches, Etudes et
Techniques (DRET)
Avail: NTIS HC/MF A20 CSCL 14/2

The real scale simulator is described which was designed by the Centre d'Etudes de Gramat (CEG) to study the coupling of fast rise time Lightning Electromagnetic pulse in a fighter aircraft. The system capability of generating the right electromagnetic environment was studied using a Finite Difference Time Domain (FDTD) computer program. First, data of inside stresses are shown. Then, a time domain and a frequency domain approach is exposed and compared. Author

10

ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A91-55418
PRECISION OF THE GYROSCOPIC DEVICES OF FLIGHT
VEHICLE CONTROL SYSTEMS [TOCHNOST'
GIROSKOPICHESKIKH USTROISTV SISTEM UPRAVLENIIA
LETATEL'NYKH APPARATOV]

LEONID I. KARGU Moscow, Izdatel'stvo Mashinostroenie, 1990, 208 p. In Russian. refs

Copyright

An attempt is made to evaluate the precision of indicating and control gyroscopes used in the closed-loop control systems of launch vehicles and spacecraft with allowance for static and dynamic errors. Attention is given to the initial setting and calibration of gyroscopic instruments, errors of gyroscopic devices and their effect on the precision of flight vehicle control systems; and possible ways of improving the precision of gyroscopic instruments. The discussion covers gyroscopic instruments of elastic flight vehicles and gyroscopic devices used in inertial navigation systems, including laser and fiber-optic gyroscopes and gyroscopes with multicascade suspensions. V.L.

A91-56106

SPACE PLANE PROGRAM IN JAPAN

MASATAKA MAITA (National Aerospace Laboratory, Chofu, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 62-70. refs

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The present paper will discuss perspectives on Japan's spaceplane research and development program. The topics will cover the current activities of Japan's spaceplane concept studies and related technology research program, which were primarily initiated by the National Aerospace Laboratory of the Science and Technology Agency, with an emphasis on the vehicle concept powered by a hypersonic airbreathing propulsion system. Author

A91-56156* NASP Joint Program Office, Wright-Patterson AFB, OH.

A CONFIGURATION DEVELOPMENT STRATEGY FOR THE NASP

CURTIS D. SNYDER (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) and S. Z. PINCKNEY (Lockheed Engineering and Sciences Co., Houston, TX) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 559-566. refs

Characteristics of airframe-integrated scramjet (AIS) aerospacecraft are studied using elementary and a recently developed AIS analysis code. Of principal interest is the definition of the AIS and what concepts offer the most potential. One of the concepts is selected for a limited optimization study aimed at defining the relationship of exhaust area to performance potential. The study shows that, if the AIS vehicle is to be fully constrained within the 'optimum' flowpath envelope, large values of exhaust-area-to-capture-area ratio are desired. A benefit of this choice is that performance at the very highest airbreather speeds is improved and, thus, may delay the need to switch to rocket power. Author

A91-56210

EXPERIMENTAL INVESTIGATION OF SIDE DUMP TYPE COMBUSTORS FOR INTEGRAL ROCKET RAMJETS

S. AOKI, K. SAKATA, T. SATO (Takasago Research and Development Center, Japan), Y. HORIUCHI, and K. KUBOTA (Mitsubishi Heavy Industries, Ltd., Nagoya Guidance and Propulsion Systems Works, Komaki, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1037-1043. refs

Copyright

This paper describes a systematic experimental study for the development of a high performance side dump combustor for an integral rocket ramjet. The experimental program consisted of flow visualization tests and combustion tests with sub and full-scale models. Several types of combustor models were tested. From the flow tests, it was found that combustor configurations with an 8-air inlet system had the best flow patterns. Full-scale combustion tests were performed for a cheek inlet combustor and a combustor

with an 8-air inlet system. The test results showed that the combustor with an 8-air inlet system has better combustion characteristics. The factors affecting combustion performance of the combustors were further investigated by testing, and finally a combustor which has stable and high combustion efficiency over 95 percent, up to stoichiometric burning, was obtained. Author

A91-56211

A NUMERICAL STUDY ON THRUST LIMITS AND FLIGHT SIMULATION OF AIR-BREATHING ROCKET

TERUO SUGIMOTO (Mitsubishi Electric Co., Central Research Laboratory, Amagasaki, Japan) and RYUICHI NAGAI (Mitsubishi Electric Co., Kamakura Works, Japan) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1044-1050. refs

Copyright

A thrust calculation program of the air-breathing engine was developed by using a simple one-dimensional model. The calculation was made and showed that air-to-fuel ratio was one of the important parameters which affect the thrust performance. There were two limits of specific impulse Isp for the subsonic operation mode; one was the maximum Isp which was the envelope of Isp lines with constant air-to-fuel ratios at optimum conditions, and the other was caused by the thermal choke in the combustion chamber. Flight simulations were also made for missiles with the air-breathing engine by making use of this thrust calculation program. It was found that the flight distance was extended 7 or 8 times longer for SAM and 2 or 3 times for AAM than the conventional solid rocket motor. Longer flight distance was expected by tuning the burning rate of propellant to decrease during the flight at appropriate Mach number and attitude.

Author

A91-56988

INTEGRATED GPS/GLONASS FOR RELIABLE RECEIVER AUTONOMOUS INTEGRITY MONITORING (RAIM)

MARK A. STURZA and ALISON K. BROWN (NAVSYS Corp., Monument, CO) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 9-13. Research supported by FAA. refs

The availability of RAIM for the GPS 21 Satellite Primary constellation, the Integrated GPS/Glonass constellation, and the operational Glonass constellation is evaluated. It is shown that after three satellite failures the individual GPS and Glonass constellations RAIM availability degrades to 92 percent for enroute and terminal phase of flights and 87 percent for nonprecision approach. The integrated GPS/Glonass constellation will provide 100 percent availability for all phases of flight even after six satellite failures (three Glonass and three GPS). R.E.P.

A91-56998

PERFORMANCE TEST RESULTS OF A FAULT-TOLERANT INERTIAL REFERENCE SYSTEM

MAHESH K. JEERAGE (Honeywell Systems and Research Center, Minneapolis, MN) IN: Institute of Navigation, Annual Meeting, 46th, Atlantic City, NJ, June 26-28, 1990, Proceedings. Washington, DC, Institute of Navigation, 1990, p. 193-199. refs

This paper presents the performance test results of a fault-tolerant inertial reference system featuring skewed axis inertial sensors, sensor redundancy management scheme, and fault-tolerant electronics. This system, built by Honeywell Commercial Flight Systems Group, was calibrated and tested in the laboratory by Honeywell Systems and Research Center. This system was flight tested in 1989, by Boeing Commercial Aiplane Company, with excellent navigation and failure detection and isolation performance. A brief description of the system is presented in the paper with emphasis on the fault-tolerant aspects. The performance test results presented include nominal navigation performance and navigation performance under sensor failures. Performance of the failure detection and isolation scheme is also presented. Author

CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A91-54394

TESTING TRANSMISSION LUBRICANTS - THE IMPORTANCE OF THERMAL RESPONSE

A. V. OLVER (Westland Helicopters, Ltd., Yeovil, England) Institution of Mechanical Engineers, Proceedings, Part G - Journal of Aerospace Engineering (ISSN 0954-4100), vol. 205, no. G1, 1991, p. 35-44. Research supported by Ministry of Defence Procurement Executive. refs

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The role of the thermal characteristics of the lubricant testing machine is investigated, and the results are used to resolve the apparent contradictions in the lubricant ranking order obtained from different test methods. A simple method is proposed for calculating the temperature of the contacting surfaces of disc machines both during and immediately prior to contact. The theoretical predictions agree well with infrared thermometer measurements taken on a disc machine. The performance of two lubricants that show a reversal in ranking order at a particular temperature is examined.

V.L.

A91-55400

TWO-LAYER MECRALY/ZRO₂ COATINGS FOR THE PROTECTION OF HIGH-TEMPERATURE NICKEL ALLOYS [DVUKHSLOINYE POKRYTIIA MECRALY/ZRO₂ DLIA ZASHCHITY ZHAROPROCHNYKH NIKELEVYKH SPLAVOV]

B. A. MOVCHAN, I. S. MALASHENKO, N. P. VASHCHILLO, and K. I. IAKOVCHUK IN: Heat-resistant inorganic coatings. Leningrad, Izdatel'stvo Nauka, 1990, p. 206-211. In Russian. refs

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Results of an experimental study of the microstructure and thermal cycling fatigue of two-layer MeCrAlY/ZrO₂ coatings produced by the electron beam evaporation of nickel and cobalt alloys and sintered ceramics are reported. It is shown that, under conditions of thermal cycling, the service-related properties of the coatings are largely determined by the kinetics of formation of an alpha-Al₂O₃ oxide film at the metal-ceramic interface; the optimal layer thickness is 60-100 microns. The longest lives are obtained with CoCrAlY/ZrO₂ coatings on ZhS6U and ChS70VI alloys.

V.L.

A91-55410

EFFECT OF ANTICORROSION COATINGS IN TANKS ON THE QUALITY OF JET FUELS [VLIANIE PROTIVOKORROZIONNYKH POKRYTII V REZERVUARAKH NA KACHESTVO REAKTIVNYKH TOPLIV]

V. A. MITIAGIN, V. S. IAKOVLEV, N. N. ZAKHAROVA, and A. P. KRIUCHKOVA (Vsesoiuznyi Nauchno-Issledovatel'skii Institut Neftianoi Promyshlennosti, Kuibyshev, USSR) Khimiia i Tekhnologii Topliva i Masel (ISSN 0023-1169), no. 8, 1991, p. 14-16. In Russian. refs

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In order to test the effect of various anticorrosion coatings used in fuel-storage tanks, full-scale experiments were conducted on the jet fuel RT, whose quality is essential for flight safety. The coatings investigated included coatings based on epoxy resins, a vinyl chloride-vinyl acetate copolymer, and liquid glass with zinc powder. It is found that none of the coatings tested has a negative effect on the quality of the fuel. The coatings are recommended for the corrosion protection of the internal surfaces of fuel-storage tanks.

V.L.

A91-55698* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

HOT CORROSION OF SILICON CARBIDE AND SILICON NITRIDE AT 1000 C

DENNIS S. FOX, NATHAN S. JACOBSON, and JAMES L. SMIALEK (NASA, Lewis Research Center, Cleveland, OH) IN: Corrosion and corrosive degradation of ceramics; Proceedings of the International Symposium, Anaheim, CA, Nov. 1, 2, 1989. Westerville, OH, American Ceramic Society, Inc., 1990, p. 227-249. refs

Copyright

The sodium sulfate hot corrosion of silicon-based ceramics at 1000 C has been extensively studied. Deposition of the sodium sulfate corrodant from combustion products is discussed in relation to sodium air impurity and sulfur fuel impurity content. Corrosion occurs by the combined processes of oxidation to form protective silica scales and dissolution of these scales to form nonprotective sodium silicates. The chemical corrosion mechanisms are presented in terms of acidic/basic dissolution of oxides in molten salts. The reactions are strongly influenced by the presence of free carbon in the ceramic. Strength reductions have been measured and are attributed to pitting in SiC and grain boundary attack in Si₃N₄. Initial results of burner corrosion of two ceramic matrix composites are consistent with the models developed for monolithic ceramics.

Author

A91-56141

THE INFLUENCE OF FUEL PLACEMENT ON NO(x) EMISSIONS FROM FLAMES STABILISED BY RADIAL SWIRLERS

H. S. ALKAIBE and G. E. ANDREWS (Leeds, University, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 411-420. Research supported by SERC. refs

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Curved blade radial swirl burners were investigated with applications to lean burning gas turbine combustor primary zones with low NO(x) emissions. Detailed internal flame composition profiles were measured for propane and kerosene fuels using single point gas sampling. Equivalence ratio, flame temperature, and combustion efficiency contours were computed from the gas analysis samples. A 140-mm diameter atmospheric pressure combustor was used with 43 percent of the combustor air flow into the primary zone through the radial swirler. Three modes of fuel injection were compared: central radial outward, radial swirler passage injection, and peripheral radial inward injection at the swirler outlet plane. The radial gas composition measurements showed that the flame stability and NO(x) emissions were controlled by differences in local mixing at the base of the swirling shear layer downstream of the swirler outlet. For radial passage fuel injection and peripheral injection at the swirler outlet, the potential for a dry solution to the NO(x) emissions problem of gas turbines was demonstrated, with an improved flame stability compared with a fully premixed system.

Author

A91-56231* Queensland Univ., Brisbane (Australia).

SUPERSONIC COMBUSTION WITH TRANSVERSE, CIRCULAR WALL JETS

R. G. MORGAN and R. CASEY (Queensland, University, Brisbane, Australia) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1211-1218. refs

(Contract NAGW-674)

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A series of experiments are reported using inclined circular wall jets in rectangular scramjet combustion chambers configured as constant area ducts. A free piston shock tunnel was used to create inlet flow Mach numbers between 4.2 and 5.5, at enthalpies corresponding to flight speeds of between 3.5 and 5.3 km/s. Measurements of duct static pressure levels indicated that

significant mixing and combustion was achieved. Using hydrogen as a fuel, it was found that multipoint injection from two sides of the duct gave a larger, and more rapid, pressure rise. In hypersonic flow, it was found that combustion only occurred for the same duct dimensions and operating conditions that supported combustion with central injection from a two-dimensional strut. Wall injection from discrete orifice circular jets was found to be more effective than two-dimensional wall injection across the whole width of the duct. Author

A91-56235

EFFECT OF FUEL PROPERTIES ON THE BURNING CHARACTERISTICS IN A SOLID FUEL RAMJET

ALON GANY (Technion - Israel Institute of Technology, Haifa) and ILAN HADAR IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1250-1259. refs

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Burning characteristics in a solid fuel ramjet (SFRJ) are analyzed. The research proposes a model permitting the prediction of the fuel regression rate on the basis of known fuel properties and flowfield characteristics. The two major phenomena involved in the fuel gasification process, namely, heat transfer from the gas phase flame to the surface and polymer decomposition kinetics, were evaluated, revealing that heat transfer is the rate controlling step of the fuel regression. Static firing tests of small SFRJ motors employing four polymeric fuel types demonstrated excellent qualitative agreement with model predictions. Author

A91-56947

CREEP OF MONOLITHIC AND SiC WHISKER-REINFORCED MOSI₂

K. SADANANDA, H. JONES, J. FENG (U.S. Navy, Naval Research Laboratory, Washington, DC), J. J. PETROVIC (Los Alamos National Laboratory, NM), and A. K. VASUDEVAN (U.S. Navy, Office of Naval Research, Arlington, VA) Ceramic Engineering and Science Proceedings (ISSN 0196-6219), vol. 12, Sept.-Oct. 1991, p. 1671-1678. refs

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Creep deformation of MoSi₂ with and without reinforced SiC whiskers was studied under uniaxial compression in the temperature range 1100-1400 C. The creep rates were significantly reduced by the presence of SiC whisker reinforcement. The reduction is attributed to increased resistance to plastic flow and inhibition of grain boundary sliding. From the activation energy and *n* values, it is concluded that the overall creep deformation at high *T* in both the composite and the monolithic MoSi₂ is controlled by dislocation climb process, while in the monolithic MoSi₂ at low *T*, it is controlled possibly by combined grain boundary sliding and climb process. O.G.

A91-56971

DENSIFICATION OF A THICK DISK PREFORM WITH SILICON CARBIDE MATRIX BY CVI PROCESS

T. HUYNH, C. V. BURKLAND, and B. BUSTAMANTE (Aercom, Chatsworth, CA) Ceramic Engineering and Science Proceedings (ISSN 0196-6219), vol. 12, Sept.-Oct. 1991, p. 2005-2014. Research supported by Teledyne CAE. refs

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A chemical vapor infiltration (CVI) process was used to fabricate a ceramic matrix composite (CMC) bladed rotor. The demonstration article was based on an uncooled design for an expendable turbine engine. A thick-disk preform of 2-D polar woven Nicalon fiber was densified with silicon carbide matrix by CVI process. The composite disk was densified to 90 +/- 2 percent of the theoretical density (about 2.94 g/cu cm). The densified composite disk was ultrasonically machined into net shape per design configuration. The machining operation included conventional surface grinding and computerized ultrasonic machining of the blades. The evaluation of the CMC rotor included NDE, microstructural analysis, micromechanical material modeling, finite element disk analysis, and a cold spin test. O.G.

A91-57023

EFFECTS OF BOND COAT PREOXIDATION ON THE PROPERTIES OF ZrO₂-8 WT. PCT Y₂O₃/Ni-22Cr-10Al-1Y THERMAL-BARRIER COATINGS

W. LIH, E. CHANG (National Cheng Kung University, Tainan, Republic of China), B. C. WU (Industrial Technology Research Institute, Hsinchu, Republic of China), and C. H. CHAO (Aero Engine Factory, Aero Industry Development Center, Kang-Shan, Republic of China) Oxidation of Metals (ISSN 0030-770X), vol. 36, Oct. 1991, p. 221-238. refs

Copyright

Plasma-sprayed thermal barrier coatings (TBCs) consist of an intermediate MCrAlY bond coat to protect the substrate superalloy from oxidation/hot corrosion and a thermal insulating-zirconia-based ceramic top coat. This system is developed for advanced turbine-engine, hot-section components. In this study, the as-sprayed Ni-22Cr-10Al-1Y bond coat was subjected to preoxidation treatment at 1000 C for 1, 50, 100, and 200 hr, also at 1100 C, 1200 C and 1300 C for 1 hr to form an oxide scale before subsequent deposition of a ZrO₂-8 wt pct Y₂O₃ top coat. The oxidation kinetics were measured, and the phase constitution and morphology of pregrown oxides on the Ni-22Cr-1Y bond coat were analyzed by X-ray diffractometer and SEM/EDS to elucidate the improvement and degradation mechanisms of the new system. The results of the experiments in this study showed that the tentative ZrO₂-8 wt. pct Y₂O₃ TBC specimens with preoxidized Ni-22Cr-10Al-1Y bond coat, when properly processed, exhibited lower oxidation rates and generally longer lifetime compared with traditional TBC specimens. Author

N91-31282# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.

CORROSION FATIGUE CRACK ARREST IN ALUMINIUM ALLOYS

R. J. H. WANHILL and L. SCHRA 4 Aug. 1988 42 p Presented at the ASTM Symposium on Evaluation and Techniques in Fractography, Atlanta, GA, Nov. 1988 Sponsored by Netherlands Agency for Aerospace Programs (NLR-MP-88050-U; ETN-91-99652; AD-B153463L) Avail: NTIS HC/MF A03

Corrosion fatigue crack retardation and arrest in two high strength aluminum alloys was investigated. Results indicate that two mutually competitive processes, hydrogen embrittlement and crack tip blocking by corrosion products, have opposing effects on low stress intensity fatigue. Crack blocking is dominant at the lowest stress intensities. Prospects for enhancing corrosion fatigue crack arrest, and hence the durability of aircraft structures, are reasonable. It is suggested that multifunctional inhibitors could be added to the environment and metal surface treatments to promote corrosion product build up and prevent hydrogen entry at the crack tip. ESA

N91-31294 Michigan Technological Univ., Houghton.

CERAMIC COMPOSITION Patent

TSENG-YING TIEN, inventor 31 Jan. 1989 48 p (PATENT-1-249-609; INT-PATENT-CLASS-C04B-3510; CTN-91-60147) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

An improved ceramic composition is described particularly relative to the high temperature properties required in such applications as ceramic engines or ceramic lined engines. The material should be suitable for application as a light diesel engine cylinder and head liner, in hot adiabatic engines, gas turbine engines, and recuperator heat exchanger applications. The matrix phase of the ceramic is selected for the group consisting of solid solutions characterized by the formula Al₂O₃(x)Cr₂O₃ and the formula 3Al₂O₃.2SiO₂ + (x) (Cr₂O₃.2SiO₂) where (x) is the relative mole fraction of Cr₂O₃ or Cr₂O₃.2SiO₂. The disperse phase is characterized by the formula ZrO₂(y)HfO₂ where (y) is the relative mole fraction of HfO₂. These ceramics exhibit significantly improved hardness and fracture toughness, as well as low thermal

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conductivity at ultrahigh combustion temperatures, and high resistance to thermal shock, wear, and corrosion. CISTI

N91-32175# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.

TESTS OF SALINIC CLOUDS IN TEST TUBE OF THE 7075 CARBON FIBER WITH METAL MESH (AIRBUS 330/340)
[ENSAYO DE NIEBLA SALINA EN PROBETAS DE 7075/FIBRA DE CARBONO CON MALLA METALICA (AIRBUS 330/340)]

1990 11 p In SPANISH
(INFORME-I-520/90; ETN-91-90058) Avail: NTIS HC/MF A03

Results obtained in corrosion resistance tests of two types of metal mesh in carbon fiber laminate are summarized. The aim of the tests was to evaluate the galvanic corrosion possibility in metal-carbon contact that could happen in these types of configuration, used as protection against beams in the A-330/340 program. ESA

N91-32180*# Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.

STRUCTURAL CHARACTERIZATION OF HIGH TEMPERATURE COMPOSITES Final Report, 10 Dec. 1982 - 30 Sep. 1985

J. F. MANDELL and D. H. GRANDE Oct. 1991 59 p
(Contract NSG-377)

(NASA-CR-187220; NAS 1.26:187220) Avail: NTIS HC/MF A04
CSCL 11/4

Glass, ceramic, and carbon matrix composite materials have emerged in recent years with potential properties and temperature resistance which make them attractive for high temperature applications such as gas turbine engines. At the outset of this study, only flexural tests were available to evaluate brittle matrix composites at temperatures in the 600 to 1000 C range. The results are described of an ongoing effort to develop appropriate tensile, compression, and shear test methods for high temperature use. A tensile test for unidirectional composites was developed and used to evaluate the properties and behavior of ceramic fiber reinforced glass and glass-ceramic matrix composites in air at temperatures up to 1000 C. The results indicate generally efficient fiber reinforcement and tolerance to matrix cracking similar to polymer matrix composites. Limiting properties in these materials may be an inherently very low transverse strain to failure, and high temperature embrittlement due to fiber/matrix interface oxidation. Author

N91-32184 Georgia Inst. of Tech., Atlanta.

FAILURE MECHANISMS AND PREDICTION IN ADVANCED COMPOSITE MATERIALS Ph.D. Thesis

KEMAL LEVEND PARNAS 1990 213 p

Avail: Univ. Microfilms Order No. DA9124541

The failure mechanisms in composite rotorcraft structures were investigated. The crippling of thin walled composite members and the delamination of tapered composite laminates were chosen as two generic applications. One is from the airframe, while the other is from the rotary components. I-section beams were used for the failure characterization of thin walled members. The local buckling, postbuckling, and crippling analysis results were compared with data obtained from compression tests. Further, a linear law for crippling was developed. An analysis of the delamination in tapered composite laminates under tensile loading was performed. Energy based methods were used to determine interlaminar stresses. The total strain energy release rate which governs the delamination behavior was determined using a simplified model. The research enables the implementation of the weight savings potential of composites and provide guidelines for the design of thin wall and tapered laminated composite components. Dissert. Abstr.

N91-32223# Construcciones Aeronauticas S.A., Madrid (Spain). Subdireccion de Investigacion y Desarrollo de Tecnologia y Materiales.

RESISTANCE OF PERISHED PAINTS TO SKYDROL
[RESISTENCIA A SKYDROL DE PINTURAS DE ACABADO

(A-320)]

1990 9 p In SPANISH

(INFORME-I-536/90; ETN-91-90060) Avail: NTIS HC/MF A02

Problems appearing in the paint work of the A-320 Airbus landing gear, due to the high temperature projection of Skydrol (trademark) produced in this region, are addressed. A test to introduce changes in the paintwork of the parts to improve resistance to this hydraulic fluid is proposed. ESA

N91-32605*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

MODELING OF ELECTRICALLY THICK MATERIALS
THEORETICAL AND EXPERIMENTAL ASPECTS

V. GOBIN, F. ISSAC, and F. JAILLOT In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991
Previously announced in IAA as A91-45609

Avail: NTIS HC/MF A99 CSCL 11/4

The shielding effectiveness of modern aircraft depends upon the nature and the electromagnetic properties of the materials used. It was shown that thin materials are modeled well by a sheet surface impedance. Unfortunately, this formalism fails in the high frequency domain (when skin effect occurs) and when the materials are physically thick. The purpose is to propose a general formalism that renders the skin effect and can be used with multilayered samples. These electrically thick materials are studied using symmetrical boundary conditions applied to tangential fields. The domain of validity of the method is discussed and experimental validations are presented. Author

N91-32606*# United Kingdom Atomic Energy Authority, Abingdon (England). Lightning Test and Technology.

INVESTIGATIONS INTO THE DAMAGE FOR VARIOUS TYPES OF UNPROTECTED CARBON FIBRE COMPOSITES WITH A VARIETY OF LIGHTNING ARC ATTACHMENTS

G. W. REID In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 11 p Aug. 1991

Avail: NTIS HC/MF A99 CSCL 11/4

Very little quantitative information exists on the extent and nature of damage caused to unprotected carbon fiber composites (CFC's) due to lightning arc attachment. An initial investigation into the arc damage to three different types and various thickness of CFC's from A and C component type lightning discharges is described. The difference in damage which the two types of waveform produced and the way the area of damage varies with different levels of action integral and charge transfer is compared. In some cases, the temperature rise at the rear of the panels was recorded for various levels of action integral and charge transfer. A comparison was made of the area of damage from visual inspection and soft x ray photography, using a suitable penetrant in the damage area. It is concluded there is a need for a more detailed analysis of the damage. Author

N91-32640*# Sandia National Labs., Albuquerque, NM.

DAMAGE TO METALLIC SAMPLES PRODUCED BY MEASURED LIGHTNING CURRENTS

RICHARD J. FISHER and GEORGE H. SCHNETZER In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991 Previously announced as N91-18565 Sponsored in part by Army

Avail: NTIS HC/MF A99 CSCL 11/6

A total of 10 sample disks of 2024-T3 aluminum and 4130 ferrous steel were exposed to rocket-triggered lightning currents at the Kennedy Space Center test site. The experimental configuration was arranged so that the samples were not exposed to the preliminary streamer, wire-burn, or following currents that are associated with an upward-initiated rocket-triggered flash but which are atypical of naturally initiated lightning. Return-stroke currents and continuing currents actually attaching to the sample were measured, augmented by close-up video recordings of approximately 3 feet of the channel above the sample and by

16-mm movies with 5-ms resolution. From these data it was possible to correlate individual damage spots with streamer, return-stroke, and continuing currents that produced them. Substantial penetration of 80-mil aluminum was produced by a continuing current of submedian amplitude and duration, and full penetration of a 35-mil steel sample occurred under an eightieth percentile continuing current. The primary purpose of the data acquired in these experiments is for use in improving and quantifying the fidelity of laboratory simulations of lightning burnthrough. Author

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A91-53052

OIL MONITORING TECHNOLOGY

PHILLIP W. CENTERS (USAF, Aero Propulsion and Power Laboratory, Wright-Patterson AFB, OH) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 523-528. refs Copyright

The development, current use, and future prospects for oil-monitoring technology are reviewed, with emphasis on military turbine engine applications. The evolutionary trend from laboratory analyses to current objectives for development of online techniques is described. Current technologies with high potential for advanced wear debris and lubricant condition assessment are reviewed. Desirable attributes of such future systems are described. It is concluded that major efforts are required to develop useful, effective online systems that will have wide application. I.E.

A91-53143

COCHANNEL INTERFERENCE REJECTION USING SURFACE ACOUSTIC WAVE DELAY-DIFFERENCE DEVICES

THOMAS T. FANG (Lockheed Missiles and Space Co., Inc., Research and Development Div., Palo Alto, CA) IN: MILCOM '90 - IEEE Military Communications Conference, Monterey, CA, Sept. 30-Oct. 3, 1990, Conference Record. Vol. 3. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 956-960. refs Copyright

A method that uses a surface-acoustic-wave delay-difference device (SAW DDD) to effect signal suppression for the case of two uncorrelated signal components (one desired and one undesired) is described. This method consists of finding the SAW tap position where the average power is minimum. It is shown that when the desired and undesired signal strengths are nearly equal performance can be improved by using the maximum and minimum average powers and their positions along the length of the SAW. By using multiple SAW DDDs, a set of simultaneous equations is obtained that relates the incidence angles of more than two signals to power measurements along the SAWs. Extension of this method to the case of more than two cochannel signals is addressed. I.E.

A91-53572

SMART LASER HOLE DRILLING FOR GAS TURBINE COMBUSTORS

EDY LARAQUE (Pratt and Whitney Canada, Longueuil) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991 9 p. (SAE PAPER 911140) Copyright

A smart laser drilling system, which incorporates air flow inspection-in-process of the holes and intelligent real-time process parameter corrections, is described. The system along with good laser parameter developments is proved to be efficient for producing cooling holes which meet the highest aeronautical standards. To date, the system is used for percussion drilling of combustion chamber cooling holes. The system is considered to be very economical due to the drilling-on-the-fly capability that is capable of drilling up to 3 holes of 0.025-in. dia. per second. O.G.

A91-53583

CASE STUDIES - KEYS TO SUCCESS IN LASER PROCESSING AIRCRAFT AND TURBINE ENGINE PARTS

TERRY L. VANDERWERT (Lumonics Corp., Laserdyne Div., Eden Prairie, MN) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 8 p. (SAE PAPER 911167) Copyright

Examples of current industrial applications of multiaxis laser systems, illustrating important features of laser processing equipment, are presented. It is shown that these systems integrated into the design and manufacturing functions maximize their benefits. O.G.

A91-53590

CRYOGENIC HEAT EXCHANGERS - KEY TECHNOLOGIES FOR PRECOOLED TURBOJET ENGINES

V. V. BALEPIN, E. A. FOLOMEEV, S. M. GALKIN, and E. A. SVETLAKOV (Tsentral'nyi Nauchno-Issledovatel'skii Institut Aviatcionnogo Motorostroeniia, Moscow, USSR) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 10 p. refs (SAE PAPER 911183) Copyright

The mass of hydrogen-air heat exchangers (HAHE) for advanced airbreathing launch vehicle powerplants depends on the specific engine cycle used, the depth of air cooling it requires, and the heat-transfer scheme employed. While HAHEs for conventional turbojet precooled could be as little as 5-15 percent of total engine mass, the figure for an air turbo ramjet with deep cooling reaches 24-35 percent of engine mass. Attention is presently given to design features for the prevention of frost formation during lower-atmosphere operation of such a powerplant, in view of experimental results obtained with humid nitrogen flow. O.G.

A91-53842

OPTIMAL CONSTRAINED VISCOELASTIC TAPE LENGTHS FOR MAXIMIZING DAMPING IN LAMINATED COMPOSITES

P. R. MANTENA (Mississippi, University, University), RONALD F. GIBSON, and SHWILONG J. HWANG (Wayne State University, Detroit, MI) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1678-1685. refs (Contract DAAL03-88-K-0013) Copyright

The results of experimental investigations conducted on glass/epoxy and graphite/epoxy composite laminated beams with constrained layer surface-damping treatments are reported. A fast Fourier transform based impulse technique is used for identifying an optimal length of damping tape to be applied for maximizing the structural loss factor. This requirement stems from a need (as in helicopter rotor blade applications) for a tradeoff between the added weight of the viscoelastic layer and the resultant changes in the dynamic characteristics of the structure. The experimental data is compared with analytical results obtained by a modal strain energy/three-dimensional finite element method. This study has shown that, for a given composite structure and boundary conditions, there exists an optimum length of the constraining layer that produces maximum shear strain energy of the intermediate viscoelastic layer, thus providing maximum damping. Boundary conditions are also shown to have a strong influence on the system damping. Author

A91-53845

RELIABILITY OF UNCERTAIN LAMINATED SHELLS DUE TO BUCKLING AND SUPERSONIC FLUTTER

D. G. LIAW and HENRY T. Y. YANG (Purdue University, West Lafayette, IN) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1698-1708. refs
(Contract NSF ECE-85-16915)

Copyright

The present study attempts to (1) ascertain the supersonic flutter characteristics of initially compressed laminate-shell structures, on the basis of a 48-DOF thin-shell finite element based on Kirchhoff-Love thin shell theory and classical lamination theory; and (2) determine the reliability of initially compressed laminated thin shells with structural uncertainties due to fabrication process-induced variables. Attention is given to the failure criteria of buckling and supersonic flutter. In order to validate and demonstrate the formulation and solution procedure, a series of vibration, buckling, and supersonic flutter analyses of thin shells are conducted with structural uncertainties under random middle surface loads. O.C.

A91-53846

RAYLEIGH-RITZ BASED SUBSTRUCTURE SYNTHESIS FOR FLEXIBLE MULTIBODY SYSTEMS

L. MEIROVITCH and M. K. KWAK (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1709-1719. Previously cited in issue 10, p. 1500, Accession no. A90-26825. refs
(Contract F49620-89-C-0049)

Copyright

A91-53883#

COMPUTER CODES FOR HSCT EXHAUST FLOWFIELD SIMULATION AND OBSERVATIONS ON TURBULENCE MODELING

S. M. DASH, N. SINHA, B. J. YORK, D. KENZAKOWSKI, and R. LEE (Science Applications International Corp., Propulsion Fluid Dynamics Div., Fort Washington, PA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 35 p. refs
(AIAA PAPER 91-3297) Copyright

The Navier-Stokes codes PARC and CRAFT have been specialized to simulate High Speed Civilian Transport (HSCT) exhaust flowfields to support the design and assessment of innovative jet noise suppression concepts. This paper will describe their current status and some of the most recent numerical upgrades. Turbulence modeling upgrades have been incorporated into these codes to deal with high Mach number compressibility, axisymmetric effects, and near-wall behavior. The behavior of the compressible-dissipation models of Sarkar and Zeman has been assessed after being cast into a k-epsilon model framework. Applications to a variety of HSCT-oriented exhaust flows (axi-jet with shocks, plug nozzle exhaust, rectangular nozzle exhaust) are presented and compared with available data. Author

A91-53980

MEASURED FIELD RELIABILITY GROWTH FROM MULTICYCLE ESS AND COMPONENT RESCREENING

WALTER E. WILLING (Westinghouse Electronic Systems Group, Baltimore, MD) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 112-118. refs
(Contract F30602-88-D-0027)

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The findings of a study of the measured field reliability improvements resulting from multiple cycle ESS on avionic systems are summarized. It is found that field MTBF improvements result from increased levels of ESS applied to identical hardware and from the implementation of component rescreening. The calculated field MTBF improvement resulting from a four-cycle Combined Environmental Reliability Test (CERT) ESS program was on the order of 28-35 percent. The field MTBF improvement due to the

rescreening of Class B components is estimated at 25 percent.

V.L.

A91-53997

HIGH LEVEL ACOUSTIC NOISE, HIGH TEMPERATURE ENVIRONMENTAL TEST PROGRAMS

PAUL LIEBERMAN, JOHN REHARD, and JOHN CZAJKOWSKI (National Technical Systems, Saugus, CA) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 580-586. refs
Copyright

The principal requirements for test procedures and test facilities for the acoustic testing of aircraft components under conditions of intense sound levels and high heat fluxes are defined. In particular, attention is given to the use of high-speed flow with attached boundary layers, unattached boundary layers, and oscillating shock wave to properly simulate pressure oscillations and heat transfer. It is also suggested that combustion be used to attain high heat fluxes over large panels at reasonable cost. A simulator is proposed in which high-speed flow, combustion, and oscillatory shock act on the test specimen. V.L.

A91-54002

COMPARISON BETWEEN EMPIRICAL MODELS OF ACOUSTIC NOISE AND FIELD MEASURED DATA FOR AIRBORNE SYSTEMS

Z. SHERF, P. HOPSTONE, R. KLEIN, and G. OSTROVSKI (Rafael Armament Development Authority, Haifa, Israel) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 688-693. refs
Copyright

Overall pressure levels and power-spectral densities measured at two locations on an airborne store are compared with results predicted by two empirical models, one describing overall sound pressures only and the other describing both the overall sound pressure level and the spectral content. Both models are found to provide fairly good predictions of the measurements and may be used for acoustic noise prediction. The adoption of some conservatism is recommended for rear locations. V.L.

A91-54005

HIGH-RELIABILITY THROUGH SYSTEMS DESIGN AND QUALITY PRACTICES

TONY D. COX (General Electric Co., Aircraft Control Systems Dept., Binghamton, NY) IN: Institute of Environmental Sciences, Annual Technical Meeting, 36th, New Orleans, LA, Apr. 23-27, 1990, Proceedings. Mount Prospect, IL, Institute of Environmental Sciences, 1990, p. 729-736.

Copyright

A total quality approach has been implemented to ensure the reliability of the Low-Altitude Safety and Targeting Enhancement System designed for the A-10 aircraft. The approach emphasizes elements of teamwork, customer satisfaction, continuous improvement, robust designs, statistical thinking, management responsibility, and supplier integration. The key aspects of the program are discussed, and the effect of each implemented change or practice on reliability is assessed. V.L.

A91-54078#

CODE FOR OPTIMIZED BALLISTIC RESISTANT AIRCRAFT STRUCTURES

M. A. GOLDBERG, D. DEVITA, and V. VOLPE (Grumman Corp., Aircraft Systems Div., Bethpage, NY) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs
(AIAA PAPER 91-3164) Copyright

An interactive computer code suitable for preliminary structural design, survivability, and 'tradeoff' studies is presented herein. The program, Code for Optimized Ballistic Resistant Aircraft Structures (COBRAS), which is rooted in traditional airframe analysis techniques, assesses candidate structural wing box arrangements,

sizes the structural components, and determines the weight of each configuration. Nominated structures are then subjected to selected damages associated with anticipated shotlines. For damaged structures, COBRAS analyzes the remaining structure for the attainable load level and can exercise a resize capability to establish the required structural integrity to sustain desired load levels. This enables clear definition of structural weight penalties associated with survivability requirements. Author

A91-54095#

APPLICATION OF PIEZOELECTRIC ELEMENTS IN SUPERSONIC PANEL FLUTTER SUPPRESSION

P. HAJELA (Rensselaer Polytechnic Institute, Troy, NY) and R. GLOWASKY (McDonnell Douglas Missile Systems Co., Saint Louis, MO) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs

(AIAA PAPER 91-3191) Copyright

The present paper examines the feasibility of using both surface bonded and embedded piezoelectric elements in the suppression of dynamic aeroelastic instabilities of panel structures. A method to determine the induced strain created by the piezoelectric element and an analysis scheme capable of determining the point of dynamic instability of a panel was developed. A formal design methodology was adopted for the optimal sizing of panels integrated with such strain inducing devices. A multicriterion design problem to simultaneously minimize the structural weight and maximize the critical flutter dynamic pressure of a typical panel was also investigated. This paper also examines the extent to which the aeroelastic characteristics of a composite panel may be altered by embedding piezoelectric fibers in a laminated composite panel. Author

A91-54096#

A COMPOSITE TURBINE BLADE OPTIMIZATION FOR MAXIMUM STRENGTH

IFTIKHAR U. HAQ and SOM R. SONI (AdTech Systems Research, Inc., Dayton, OH) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs

(Contract F33615-87-C-5336)

(AIAA PAPER 91-3192) Copyright

Prediction of strength characteristics of a composite structure depends upon a large number of parameters including ply orientation, ply thickness, stacking sequence and geometry. Analytical solutions alone are not sufficient for practical design considerations. In this work, effective application of a numerical optimization method has been demonstrated for the design of a turbine blade, rotating at high angular velocity. The analytical blade model is based on the free edge stress observations for large width-to-thickness composite configuration. Ply strength ratios and blade weight were selected as the objective functions. Ply orientations and blade thickness were chosen as the design variables, in separate cases. Maximum stress and quadratic failure criteria were satisfied at multiple cross-sections to obtain the optimum design. Author

A91-54276

THE DEVELOPMENT OF A SYSTEM FOR REAL-TIME, FULL-FIELD SURFACE SHEAR STRESS MEASUREMENTS USING LIQUID CRYSTALS

N. TOY, E. SAVORY, and S. PASKIN (Surrey, University, Guildford, England) IN: Symposium on Turbulence, 12th, Rolla, MO, Sept. 24-26, 1990, Preprints. Rolla, MO, University of Missouri-Rolla, 1990, p. B15-1 to B15-8. Research supported by Department of Trade and Industry of England. refs

Copyright

The use of liquid crystal properties in wind tunnel investigations for measuring surface shear stress is described. A video digitization technique is employed representing the video image by its three component colors. The calibration of the liquid crystal is detailed along with the subsequent shear stress distribution on a liquid crystal coated swept fin. Author

A91-54278

FLOW GRADIENT CORRECTIONS ON HOT-WIRE MEASUREMENTS USING AN X-WIRE PROBE

J. H. M. GOODEN (National Aerospace Laboratory, Emmeloord, Netherlands) and M. VAN LENT (Fokker Aircraft, Schiphol, Netherlands) IN: Symposium on Turbulence, 12th, Rolla, MO, Sept. 24-26, 1990, Preprints. Rolla, MO, University of Missouri-Rolla, 1990, p. B18-1 to B18-13. Research supported by Netherlands Agency for Aerospace Programs. refs

Copyright

A method has been developed to correct hot-wire measurements by means of a single X-wire probe for the effect of gradients normal to the plane of the wires in the mean flow velocities as well as in the turbulence intensities. Dataprocessing is performed in an iterative way, using the results of measurements with different probe rolling angles, to determine the gradient corrections along the traverse from the previous loop. The method has been applied to measurements in the wake above the trailing edge flap of a wing and it is shown that substantial improvements in the results have been achieved. Author

A91-54367

PERFORMANCE OF THE INTERNAL CONFIGURATION OF A PROTOTYPE TRUE AIRSPEED SENSOR

GREGORY V. SELBY (Old Dominion University, Norfolk, VA) and ADEL R. IBRAHIM (Newport News Shipbuilding and Drydock Co., VA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Oct. 1991, p. 618-621. refs

Copyright

An experimental study of the internal configuration of a prototype true airspeed sensor has been conducted in order to identify the geometric parameters that have a significant effect on sensor frequency response characteristics. The basic sensor configuration studied primarily consisted of vortex generator and vortex tube sections, along with an acoustic signal detection circuit. The geometric parameters varied in the 60 sensor configurations tested included vortex tube diameter, vortex generator diameter, signal detection location, and exit nozzle length, listed in order to their relative effect on acoustic frequency. In addition, a linear relationship between frequency and volumetric flow rate over a range of 0.07 to 0.95 cu ft/min was observed. Author

A91-54566

CAUSES OF AIRCRAFT ELECTRICAL FAILURES

DONALD GALLER (Failure Analysis Associates, Inc., Kusko Electrical Div., Westborough, MA) and GEORGE SLENSKI (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, Aug. 1991, p. 3-8. refs

(Contract F33615-89-C-5647)

Copyright

The results of a survey of data on failures of aircraft electronic and electrical components that was conducted to identify problematic components are reported. The motivation for the work was to determine priorities for future work on the development of accident investigation techniques for aircraft electrical components. The primary source of data was the Airforce Mishap Database, which is maintained by the Directorate of Aerospace Safety at Norton Air Force Base. Published data from the Air Force Avionics Integrity Program (AVIP) and Hughes Aircraft were also reviewed. Statistical data from these three sources are presented. Two major conclusions are that problems with interconnections are major contributors to aircraft electrical equipment failures, and that environmental factors, especially corrosion, are significant contributors to connector problems. I.E.

A91-54569

270-VDC/HYBRID 115-VAC ELECTRIC POWER GENERATING SYSTEM TECHNOLOGY DEMONSTRATOR

R. E. NIGGEMANN, S. PEECHER, and G. ROZMAN (Sundstrand Aerospace, Rockford, IL) IEEE Aerospace and Electronic Systems Magazine (ISSN 0885-8985), vol. 6, Aug. 1991, p. 21-26. refs

Copyright

The approach, system architecture, instrumentation, and performance of a technology demonstrator system for the application of 270-Vdc/hybrid 115-Vac electrical power generation and distribution to future military aircraft are examined. The design has focused on assembling a highly flexible test system. The loads are typical of those in a hybrid electrical system. The system consists of a single 3-phase, 115-Vac electrical generator whose output is rectified, filtered, and supplied through dc contactors to both a 270-Vdc load bus and to the input of an inverter, which supplies a 400-Hz, 115-Vac load bus. A variable-frequency, 115-Vac bus is also available directly from the generator. A prototype variable-speed constant-frequency 120-kVA generator is used. The test facility is designed to provide loads to all power types capable of being produced by the system. The system has provided particularly good insight into various aspects of 270-Vdc/115-Vac hybrid systems and their components. I.E.

A91-54574

REEVALUATION OF THE PERFORMANCE OF GAS TURBINE AXIAL COMPRESSOR CASCADES BASED ON THE INFLUENCE OF THE REYNOLDS NUMBER [AUFWERTUNG DES WIRKUNGSGRADES VON GASTURBINEN-AXIALVERDICHTERBESCHAUFELUNGEN UEBER DEN EINFLUSS DER REYNOLDSZAHL]

HORST STOFF and RENE WAELCHLI (ABB Kraftwerke AG, Baden, Switzerland) Forschung im Ingenieurwesen (ISSN 0015-7899), vol. 57, Sept. 1991, p. 162-164. In German. refs Copyright

A comparison is made between compressors of two types of construction and different sizes and profile families. It is shown that the exponent $-1/8$ in the Reynolds number evaluation formula and the recomputation of the Sand roughness/mean roughness $= 6.3$ permits a recalculation of the effect of compressor size on the performance. The accuracy is about that attainable from thermal measurements. C.D.

A91-54588

A RAPID-ACQUISITION ARCHITECTURE FOR ADVANCED AVIONICS AND SPREAD-SPECTRUM APPLICATIONS

MICHAEL T. JORDAN and JAMES R. LUECKE (Interstate Electronics Corp., Anaheim, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 76-80. refs Copyright

A rapid-acquisition architecture for frequency hopping (FH), direct sequence (DS), and various forms of hybrid spread-spectrum waveforms is presented. This concept offers extraordinary improvements in flexibility and adaptability, as well as significant advantages in size, weight, and power reduction over those of conventional systems. The general concept is based on matching application-specific IC variable-length digital matched filter technology to programmable digital frequency synthesizers for an adaptable FH/DS spread-spectrum system. Within a given time interval a specific set of outputs from each code-matched filter (CMF) appears which represents the correlation of the received signal against a certain code offset. This is the key function for fast and reliable acquisition of the spread-spectrum signals. The basic configuration consists of the fast-acquisition subsystem, which receives the signals and downconverts, or dechips, by a frequency-hopping local oscillator driven by the known pseudonoise frequency hop pattern. This architecture configuration offers ease of technology insertion as new developments in technology may emerge. The modular philosophy allows for future expansion of the initial architecture in a cost-effective manner. I.E.

A91-54637

INTERFACE AND WIRING DESIGN TO ALLEVIATE THE IMPACT OF HIGH-ENERGY RF FIELDS UPON SIGNAL TRANSMISSION

TIM RICHMOND (Litton Systems, Inc., Guidance and Control Systems Div., Woodland Hills, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18,

1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 392-400. refs Copyright

It is pointed out that the effects of high-energy RF (HERF) upon avionic system operation can be reduced to a benign level if the external interface circuits and cabling possess sufficient design margin to allow continuous and accurate operation while this radiated threat is present. Digital interfaces constructed of balanced and differential transceivers can obtain in excess of 15 dB rejection of the coupled common-mode threat when compared to single-ended circuits. It is noted that transformer coupling of balanced, differential interface circuits to the cable will further reduce the amount of coupled common-mode noise detected by the receiving circuit. The effectiveness of cable shielding with overbraid is strongly dependent on the shield termination at each cable end; peripheral terminations into EMI backshells can offer up to 30-dB greater shielding effectiveness than wire (pigtail) terminated shields. I.E.

A91-54677

SOCIETY OF AUTOMOTIVE ENGINEERS AS4074 FAMILY HIGH-SPEED, FAULT-TOLERANT DATA COMMUNICATIONS STANDARDS FOR INTEGRATED AVIONICS

JOHN W. MEYER (Boeing Aerospace and Electronics, Seattle, WA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 651-656. refs Copyright

The Society of Automotive Engineers (SAE) has been addressing the need for data buses in advanced avionics systems. Since 1979, the SAE has had task groups developing a family of commercial data bus standards designed specifically for the unique fault-tolerant requirements of avionics applications: AS4074.1 linear, token-passing multiplex data bus (LTPB), and AS4074.2 high-speed ring bus (HSRB). The author explains the background of the two bus standards, gives a brief overview of the two protocols, and reviews current and future SAE activities in the avionics data bus field. It is concluded that the SAE LTPB and HSRB satisfy the data latency needs of emerging avionics architectures, as well as the reliability and fault tolerance requirements. Because of their ability to be supplemented with higher data rate versions, they will continue to support emerging avionics architectures. I.E.

A91-54847

EVALUATION OF THE DRAG FORCE BY INTEGRATING THE ENERGY DISSIPATION RATE IN STOKES FLOW FOR 2D DOMAINS USING THE FEM

RAM K. GANESH (Connecticut, University, Storrs) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 13, Sept. 5, 1991, p. 557-578. refs Copyright

The total drag force on the surface of a body, which is the sum of the form drag and the skin friction drag in a 2D domain, is numerically evaluated by integrating the energy dissipation rate in the whole domain for an incompressible Stokes fluid. The finite element method is used to calculate both the energy dissipation rate in the whole domain as well as the drag on the boundary of the body. The evaluation of the drag and the energy dissipation rate are post-processing operations which are carried out after the velocity field and the pressure field for the flow over a particular profile have been obtained. The results obtained for the flow over three different but constant area profiles - a circle, an ellipse and a cross-section of a prolate spheroid - with uniform inlet velocity are presented and it is shown that the total drag force times the velocity is equal to the total energy dissipation rate in the entire finite flow domain. Hence, by calculating the energy dissipation rate in the domain with unit velocity specified at the far-field boundary enclosing the domain, the drag force on the boundary of the body can be obtained. Author

A91-55043

RANGE PERFORMANCE OF WING-IN-GROUND EFFECT VEHICLE

SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 38, no. 440, 1990, p. 502-506. In Japanese. refs

The author has considerable interest in the range performance of wing-in-ground (WIG) effect vehicles. There are two opposite effects concerning this problem. The favorable one is well known reduction in the induced drag due to ground proximity. While the unfavorable is no utilization of reduction in the specific fuel consumption of gas turbine engines at high altitude. Simple calculations show that WIG is suitable for shorthaul operation, about 1000 km, than long range, about 10,000 km. Merits and demerits of changing the geometric wing-aspect-ratio or flight dynamic pressure are discussed. Author

A91-55133

STABILITY STUDY OF COUPLING RESPONSES IN LAMINATES

GIN B. CHAI and POH W. KHONG (Nanyang Technological University, Singapore) Journal of Composites Technology and Research (ISSN 0885-6804), vol. 13, Fall 1991, p. 187-190. refs Copyright

Flexibility of a finite strip method is presented for the analysis of laminated composites in compression. The analysis is based on the reduced bending stiffness concept and takes into account coupling responses in laminates subjected to various loading and boundary conditions. Results of parametric study of laminates indicate that the loading and edge boundary conditions can be easily varied. The finite strip method is considered to be relatively simple and can be used to establish design curves for use in industry. O.G.

A91-55267

EFFECT OF A LONGITUDINAL MAGNETIC FIELD ON THE TRANSITION OF A HIGH-VELOCITY BOUNDARY LAYER [VLIANIE PRODOL'NOGO MAGNITNOGO POLIA NA PEREKHOD VYSOKOSKOROSTNOGO POGRANICHNOGO SLOIA]

V. IA. KISELE' and V. I. LYSENKO Akademiia Nauk SSSR, Izvestiia, Mekhanika Zhidkosti i Gaza (ISSN 0568-5281), July-Aug. 1991, p. 175-177. In Russian. refs Copyright

A substantial increase in stagnation temperature at large flow velocities leads to gas dissociation and, eventually, ionization. The superposition of a magnetic field (external or induced by the flight vehicle) may shift the laminar-turbulent transition of the boundary layer on the body. Here, it is demonstrated experimentally that a longitudinal magnetic field has a stabilizing effect on a high-velocity conducting boundary layer, leading to an increase in the Reynolds number of the laminar-turbulent transition. V.L.

A91-55396

MODELING OF THE SERVICE CONDITIONS OF COATED MATERIALS IN AIRCRAFT STRUCTURES [MODELIROVANIE USLOVII RABOTY MATERIALOV S POKRYTIAMI V AVIATSIONNYKH KONSTRUKTSIIAKH]

N. V. KHOLODKOV IN: Heat-resistant inorganic coatings. Leningrad, Izdatel'stvo Nauka, 1990, p. 14-18. In Russian. refs Copyright

The heat resistance of coated materials used in aircraft structures is analyzed with allowance for the oxidizing effect of high-velocity flow of air or fuel combustion products. It is shown that the evaluation of the performance of heat-resistant coatings must include multiparametric simulations modeling in the laboratory. The material heating temperature should be calculated with allowance for the possibility of local superheating in the case of oxidation in the vicinity of defects. Test results are presented for slurry-diffusion and plasma-sprayed Si-Ti-Mo-B coatings. V.L.

A91-55456

OPTIMUM STRUCTURAL DESIGN OF CANTILEVERED RECTANGULAR ELASTIC WING WITH GUST LOAD ALLEVIATION SYSTEM

SHINJI SUZUKI and SATOSHI YONEZAWA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, Aug. 1991, p. 419-425. In Japanese. refs

The optimization of a wing structure with a gust-load-alleviation (GLA) system is presented as a method to evaluate the weight reduction of the wing structure. A wing spar is discretized into a set of beam elements using the finite element method. The GLA system controls an aileron deflection using the feedback of a wing-accelerometer signal. Goal-programming formulation is used to find optimal solutions. A reference model is the optimized structure without the GLA system. The quantity of the weight reduction is estimated with the structural optimization of the reference model with the GLA system. In addition, a wing-stress level resulting from the GLA system failure and the aileron deflection angle for active control are calculated. Author

A91-55515

FIBER OPTIC SMART STRUCTURES - STRUCTURES THAT SEE THE LIGHT

RAYMOND M. MEASURES (Toronto, University, Downsview; Ontario Laser and Lightwave Research Centre, Canada) IN: Optical testing and metrology III: Recent advances in industrial optical inspection; Proceedings of the Meeting, San Diego, CA, July 8-13, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 377-398. Research supported by Ontario Laser and Lightwave Research Centre, NSERC, Institute for Space and Terrestrial Science, et al. refs Copyright

The relative merits of a number of fiber optic sensors are compared in terms of their suitability for use in smart structures. It is shown that the Michelson fiber optic sensor is suitable for detecting damage-induced acoustic emission within composites in the laboratory and for testing the concept of an optical strain rosette. However, its limited application in terms of smart structures has led to the development of a Fabry-Perot fiber optic sensor for strain sensing within composite structures. A damage assessment system for composite material structures based on embedded optical fibers has been developed and fabricated within the composite leading edge of an aircraft. The results clearly support the concept of structurally integrated fiber optic damage assessment systems for composites. C.D.

A91-55518

FIBER OPTIC DAMAGE DETECTION FOR AN AIRCRAFT LEADING EDGE

RAYMOND M. MEASURES, M. LEBLANC, D. HOGG, K. MCEWEN, and B. PARK (Toronto, University, Downsview; Ontario Laser and Lightwave Research Centre, Canada) IN: Optical testing and metrology III: Recent advances in industrial optical inspection; Proceedings of the Meeting, San Diego, CA, July 8-13, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 431-443. Research supported by Ontario Laser and Lightwave Research Centre, NSERC, Institute for Space and Terrestrial Science, et al. refs Copyright

First test results of a multilayered fiber optic impact damage detection system fabricated within an aircraft wing composite leading edge are reported. The graphically presented results indicate that embedded optical fiber will track the growth of a delamination region. These results strongly support the concept of structurally integrated fiber optic damage assessment system for composites. C.D.

A91-55547* Douglas Aircraft Co., Inc., Long Beach, CA.

AI IN MANUFACTURING

JOHN E. GROSS (Douglas Aircraft Co., Long Beach, CA), RICK MINATO (Northrop Corp., Aircraft Div., Hawthorne, CA), DAVID M. SMITH (Lockheed Aeronautical Systems Co., Marietta, GA), R. B. LOFTIN (Houston, University, TX), and ROBERT T. SAVELY

(NASA, Johnson Space Center, Houston, TX) Aerospace America (ISSN 0740-722X), vol. 29, Oct. 1991, p. 32-39, 46. Copyright

All techniques are shown to have been useful in such aerospace industry tasks as vehicle configuration layouts, process planning, tool design, numerically-controlled programming of tools, production scheduling, and equipment testing and diagnosis. Accounts are given of illustrative experiences at the production facilities of three major aerospace defense contractors. Also discussed is NASA's autonomous Intelligent Computer-Aided Training System, for such ambitious manned programs as Space Station Freedom, which employs five different modules to constitute its job-independent training architecture. O.C.

A91-55590 NUMERICAL SIMULATIONS OF SUPERSONIC PLANE COUETTE FLOW INSTABILITY

N. DOLEZ (Observatoire Midi-Pyrenees; Centre Europeen de Recherche et de Formation Avancee en Calcul Scientifique, Toulouse, France) and J. LEORAT (Meudon, Observatoire, France) IN: Turbulence and coherent structures; Selected Papers from Turbulence 89, Grenoble, France, Sept. 18-21, 1989. Dordrecht, Netherlands, Kluwer Academic Publishers, 1991, p. 525-536. Research supported by CNRS. refs Copyright

Results of numerical simulations of supersonic plane Couette flow at $Re = 160$ are presented. It is shown that at this Re and Mach number of 4.9, the flow reaches a steady state with strong density fluctuations. C.D.

A91-55641* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

ACTIVE TURBULENCE CONTROL IN WALLBOUNDED FLOW USING DIRECT NUMERICAL SIMULATIONS

J. KIM, P. MOIN, and H. CHOI (NASA, Ames Research Center, Moffett Field; Stanford University, CA) IN: Structure of turbulence and drag reduction; Proceedings of the IUTAM Symposium, Zurich, Switzerland, July 25-28, 1989. Berlin and New York, Springer-Verlag, 1990, p. 417-425. refs Copyright

An exploratory study of concepts for active control of turbulent boundary layers using the direct numerical simulation technique was performed. Significant drag reduction was achieved when the surface boundary condition was modified such that it could suppress the large-scale structures present in the wall region. This was achieved by prescribing the normal component of velocity at the wall to be 180 deg out of phase with the normal velocity slightly above the wall at each instant. The drag reduction was accompanied with significant reduction in the intensity of the wall-layer structures and reductions in the magnitude of Reynolds stresses throughout the flow. Suitability of wall-pressure and shear-stress fluctuations for detection of flow structures above the wall was examined. A preliminary result obtained by applying the present control strategy to a transitional flow is also briefly described, from which one can infer a possible linkage between the control strategy and flow stability. Author

A91-55645 ANALYSIS OF THE WAKE OF AN OUTER LAYER MANIPULATOR

J. DELVILLE, J. P. BONNET (Poitiers, Universite, France), and J. LEMAY (Universite Laval, Quebec, Canada) IN: Structure of turbulence and drag reduction; Proceedings of the IUTAM Symposium, Zurich, Switzerland, July 25-28, 1989. Berlin and New York, Springer-Verlag, 1990, p. 495-502. refs Copyright

The use of external manipulators, such as blades and airfoil profiles, to achieve drag reduction is investigated experimentally using constant temperature hot-wire anemometry. The coherence of longitudinal velocity in the wake is first investigated. A slight heating of the manipulator is then used to get a passive marker of the flow. Results of the experiments are presented in graphic form. V.L.

A91-55646

INFLUENCE OF AN ACOUSTIC FIELD OF THE FLOW STRUCTURE BEHIND A LEBU IN A TURBULENT BOUNDARY LAYER

S. P. BARDAKHANOV, V. V. KOZLOV, and V. V. LARICHKIN (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: Structure of turbulence and drag reduction; Proceedings of the IUTAM Symposium, Zurich, Switzerland, July 25-28, 1989. Berlin and New York, Springer-Verlag, 1990, p. 503-506. refs Copyright

Results of a wind tunnel study of the effect of acoustic disturbances on the structure of flow behind large eddy breakup devices (LEBU) are reported. The LEBU models consisted of steel plates 1 mm thick with a rounded front and sharpened edges; the signals were processed by a hot-wire anemometer and a frequency analyzer. It is shown that, at high sound intensities, coherent structures in the wake can interact with boundary layer coherent structures and thus change the efficiency of the LEBU. V.L.

A91-55719

THREE-DIMENSIONAL WAKE VISUALIZATION IN WATER TUNNEL BY A SELECTIVE LARGE SCALE STRUCTURES THERMAL MARKING

O. RODRIGUEZ (ONERA, Institut de Mecanique des Fluides, Lille, France) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 331-337. Research supported by DRET. refs Copyright

The work verifies the usefulness of the Schlieren method for separated-flow visualizations in hydrodynamics by using a selective thermal marking of the 3D vortical structures which are present in the wake of a drag-reduction device. The comparison of the visualizations recorded in a water tunnel and in a wind tunnel allows insight into the vortical unsteady mechanism occurring in the drag-reduction device at high Reynolds numbers. Author

A91-55738

DETERMINATION OF THE GEOMETRICAL POSITION OF VORTICES IN FLOW FIELDS VISUALIZED BY LASER LIGHT SHEET

S. FOERSTER (DLR, Institut fuer Experimentelle Stroemungsmechanik, Goettingen, Federal Republic of Germany) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 523-527. refs Copyright

A method to map out the location of vortex cores as a function of body station and angle of attack by means of a digital image processing is presented. The laser light sheet technique with smoke as tracer particles was employed to visualize the vortex cores. Later on the visualization-pictures of different planes of the light sheet, stored on video-film, were digitized and fed into an image processing system. After determination of the location of the vortex cores in picture units these vortex positions were transformed into units of the model configuration by means of an appropriate algorithm. Thus, the vortex trajectories could be defined for the horizontal and vertical planes in model coordinates. Author

A91-55742

TOMOGRAPHY OF AERODYNAMIC OBJECTS

V. A. KOMISSARUK, N. P. MENDE, and L. N. POPOV (AN SSSR, Fiziko-Tekhnicheskii Institut, Leningrad, USSR) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 562-569. refs Copyright

A device has been designed for optical tomography of aerodynamic objects in a free flight; the tomograph contains five grating interferometers with ruby lasers as light sources. To reconstruct the gas density the density function was presented as a finite series with circle harmonics in ring zones. Square-law

optimization of the procedure includes parameters and confidence intervals estimation. The results are presented concerning the gas density distribution about a supersonic cone. Author

A91-55743

RECENT ADVANCES IN FLOW VISUALIZATION AT BOEING COMMERCIAL AIRPLANES

J. P. CROWDER (Boeing Commercial Airplanes, Aerodynamics Laboratory, Seattle, WA) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 573-583. refs

Copyright

Flow-visualization techniques are described which can be applied to experimental aerodynamics development for commercial aircraft. Among the techniques reviewed are the use of the IR camera for studying boundary-layer transitions, still video, and oxygen-quenched fluorescent paint. Specific applications are given for each technique with descriptions of the required equipment, and photographic results of some investigations are given.

C.C.S.

A91-55755

FLOW VISUALIZATION IN A WATER MODEL OF A CAN-TYPE GAS TURBINE COMBUSTOR

C. ARCOUMANIS, J. J. MCGUIRK, and J. M. L. M. PALMA (Imperial College of Science, Technology, and Medicine, London, England) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 813-823. Research supported by Ministry of Defence of England. refs

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Visualization of the flow in a water model of a can-type gas turbine combustor has been carried out for two swirler flow rates using both conventional and fluorescent dyes. A conventional dye was used to illustrate the trajectory of the radially inflowing jets but improved resolution could only be achieved by laser induced fluorescence. Author

A91-55756

INFRARED THERMOGRAPHY APPLICATIONS IN CONVECTIVE HEAT TRANSFER

G. M. CARLOMAGNO and L. DE LUCA (Napoli, Universita, Naples, Italy) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 843-848. refs

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The IR Scanning Radiometer (IRSR) is described in terms of applications to the measurement of convective-heat-transfer coefficients and the analysis of flow-field behavior. The heated-thin-foil technique is employed to study heat transfer from a plate to impinging jets and the laminar/turbulent transition, and hypersonic-wind-tunnel applications are given. The thermographic data from the IRSR experiments are found to be in good agreement with standard experimental data for both the steady and transient conditions. C.C.S.

A91-55758

LIQUID CRYSTAL THERMOGRAPHY FOR AERODYNAMIC HEATING STUDY

G. ZHARKOVA and V. KHACHATURIAN (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) IN: Flow visualization V; Proceedings of the 5th International Symposium, Prague, Czechoslovakia, Aug. 21-25, 1989. New York, Hemisphere Publishing Corp., 1990, p. 892-897. refs

Copyright

Aerodynamic investigations are reported in which the properties of liquid crystal (LC) thermoindicators are examined in terms of their applicability to heating experiments. The use of encapsulated LC thermoindicators is discussed when they are employed to locate the transition from laminar to turbulent flow. LC thermoindicators are useful devices for measuring inhomogeneous supersonic heat

flows on experimental models and for visualizing flow characteristics. C.C.S.

A91-55797

AUGMENTED HEAT TRANSFER IN A PIN FIN CHANNEL WITH SHORT OR LONG EJECTION HOLES

T. K. KUMARAN, J. C. HAN, and S. C. LAU (Texas A & M University, College Station) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 34, Oct. 1991, p. 2617-2628. refs

(Contract NSF CBT-87-13833)

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Experiments are performed to determine the heat transfer, pressure drop, and mass flow rate in a pin fin channel with short or long ejection holes on one of the channel sidewalls. The test section consists of eight copper segments that are individually heated to maintain an isothermal boundary wall condition. The segmentally averaged Nusselt numbers are determined. The heat transfer in the pin fin channel with sidewall ejection flow is about 25-30 percent lower than that with the straight flow. The length of the sidewall ejection holes does not significantly alter the heat transfer in the pin fin channel for the lengths of the ejection holes considered. Author

A91-55798

VAPORIZATION BEHAVIOR OF FUEL DROPLETS IN A HOT AIR STREAM

S. K. AGGARWAL, G. CHEN (Illinois, University, Chicago), T. A. JACKSON, and G. L. SWITZER (USAF, Wright-Patterson AFB, OH) International Journal of Heat and Mass Transfer (ISSN 0017-9310), vol. 34, Oct. 1991, p. 2669-2673. Research supported by USAF. refs

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Vaporization behavior of pure and multicomponent fuel droplets flowing in a well-characterized laminar flow has been studied. Predictions of three vaporization models have been compared with experimental data. It is concluded that the predicted droplet velocity shows excellent agreement with the measured data, indicating that the solid-sphere drag law is quite adequate for the conditions considered. The vaporization behavior of a multicomponent fuel droplet is better simulated by the infinite-diffusion model. The variable property effects are found to be important for an accurate prediction of droplet velocity and size. Both the effect of temperature and the effect of fuel vapor should be considered for calculating the thermophysical properties of the gas film surrounding the droplet. It is demonstrated that, for relatively low ambient temperatures, both the infinite-diffusion and diffusion-limit methods can accurately predict the vaporization of pure and multicomponent fuel droplets. O.G.

A91-56120

COMPACT HEAT EXCHANGER TECHNOLOGY FOR AERO ENGINES

G. PELLISCHEK and B. KUMPF (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 203-208. refs

Copyright

Referring to the exhaust gas recuperator of the LV100 - an advanced gas turbine to power heavy armored vehicles - the principles of the recuperated gas turbine cycle are described. Essential technological features of a highly compact profile-tube matrix are presented with respect to its application in the airbreathing propulsion field. Besides high power density and the structural reliability, easy integration - even in small engine compartments - is an outstanding characteristic. Full use has been made of broad practical experience for the innovative design of intercooled recuperative CRISP-engines, air-cooled air coolers, and cryogenically-cooled ram-air coolers for hypersonic airbreathing engines. Author

A91-56139

CARS TEMPERATURE MEASUREMENTS IN A GAS TURBINE COMBUSTOR

J. E. VAN NIEKERK, B. J. VAN DER WESTHUIZEN, R. J. HUTCHEON, and G. N. ROBERTSON (Bureau for Mechanical Engineering, Inc., Aircraft Propulsion Laboratory, Stellenbosch, Republic of South Africa) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 394-402. refs

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An XY-scanning system for manipulating high power pulsed laser beams under computer control has been developed. This beam-steering equipment enables CARS to be used for measuring temperatures in a typical gas turbine combustor. CARS data-reduction normally involves very intensive computation. However, it is desirable in general to be independent of large mainframe computers, which can clearly not be dedicated to a CARS experiment. It is therefore essential to apply an optimized reduction algorithm and a well-structured computer code to perform this task. The temperature results obtained are discussed and compared to those derived using other algorithms, as well as to results obtained from thermocouple measurements. Author

A91-56161

A NOVEL TECHNIQUE FOR THE EXPERIMENTAL DETERMINATION OF BEARING AND WINDAGE LOSSES IN AN AXIAL FLOW COMPRESSOR

S. A. GURUPRASAD and K. MOHAN (National Aeronautical Laboratory, Bangalore, India) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 599-604. refs

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This paper describes an experimental technique for the determination of bearing and windage losses in an axial flow compressor. These losses must be accurately known when the isentropic efficiency of the compressor is calculated on the basis of the input torque. In the novel technique described here, even in the absence of the normal air compression process (i.e. without blades), the same magnitude of axial and radial loads are produced on the bearings, thereby simulating the actual operating conditions of the bearings. This is achieved by replacing the compressor disc and blades by an equivalent plain disc, and admitting pressurized air on one face of this plain disc to provide the required axial thrust. Using this new experimental technique the bearing and windage losses in an axial compressor stage were accurately determined for different speed and load conditions. The inadequacies of the theoretical methods for the estimation of these losses are pointed out. The method of incorporating the experimentally determined values of the losses in efficiency calculations is indicated. Author

A91-56163

COMBUSTION AND EMISSIONS OF STEADY AND INTERMITTENT HIGH INJECTION PRESSURE SPRAYS IN A GAS TURBINE COMBUSTOR

S. H. EL-EMAM (Mansoura University, Egypt) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 617-624. refs

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An experimental investigation has been carried out to study combustion characteristics and emissions of steady and intermittent high injection pressure sprays in a gas turbine combustor. A typical diesel injection system with a pintle type diesel injector is used to supply an intermittent spray through a typical gas turbine combustor. An accumulator pressurized reservoir has been installed in the injection system to supply a steady injected spray. Measurements of temperature distributions and species concentrations has been carried out for different injection pressures ranging from 1 MPa to 20 MPa for both intermittent and steady injected spray flames. Obtained results show that the injection pressure of liquid fuel

sprays has an important role on spray combustion characteristics and emissions formations processes in the gas turbine combustors. Increasing the injection pressure, the Sauter mean diameter of spray droplets is decreased and the combustion process is considerably accelerated. A remarkable decrease occurs in nitric oxide concentrations in combustion products in the case of intermittent injected spray compared with the case of steady injected sprays. Author

A91-56190

PERIPHERAL STREAMWISE VORTICES IN A ROUND JET

D. P. GEORGIU and K. N. SAINI (Patras, University, Greece) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 852-858. refs

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A new type of entrainment-enhancement-method in which small, delta wing-like vortex generators have been fixed in the periphery of the exhaust tube, near the exit, is presented. Streamwise vortices are generated in the periphery of the jet. The reported data refer to the mean velocity and temperature fields in the near-field region (i.e., near the exit region). A special jet apparatus was erected, together with a relevant probe-transversing mechanism. The maximum flow Reynolds number was about 32,000, based on the tube diameter. The velocity measurements were done in an isothermal flow while the temperature ones in a heated jet flow. The velocity measurements were made by a calibrated 5-tube probe and the temperature was actually measured in the form of the temperature difference between a given point and the atmospheric one. Author

A91-56238

MEASUREMENTS AND COMPUTATIONS OF EXTERNAL HEAT TRANSFER AND FILM COOLING IN TURBINES

S. P. HARAGAMA, C. D. BURTON, and K. S. CHANA (Royal Aerospace Establishment, Propulsion Dept., Farnborough, England) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1276-1284. refs

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A review of recent work on turbine heat transfer performed is presented. The work covers the effects of secondary flows on turbine nozzle guide vane heat transfer with and without film cooling. It is shown that the heat load to the platforms (endwalls) are significantly affected by the secondary flow action. The platform film cooling data has been well correlated with flat-plate, single-row film cooling data to within + or - 11 percent. A three-dimensional Navier-Stokes computational study of the effects of turbine inlet temperature distortion on the thermofluid mechanics within a rotating blade passage is given. It is shown that the temperature distortion is modified within the rotor blade and can lead to increased pressure side and over tip heat transfer. Author

A91-56241

AN EXPERIMENTAL INVESTIGATION OF NON-STEADY METHODS OF ENERGY EXCHANGE IN HIGH SPEED INTERNAL FLOWS

M. I. ANJUM (George Washington University, Washington, DC) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1302-1312. refs

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For many important turbomachine applications, such as turbochargers and gas turbines, high component efficiencies are of extreme importance. Recent research at the George Washington University has shown that for small scale turbomachines, improvement in component efficiency and operating range can be achieved by using low solidity rotors. However, such low solidity rotors present a severe collection and diffusion problem, particularly

in compressors, due to the nonsteadiness of the discharged flow. The present work is directed toward studying the methods of energy exchange in low solidity turbomachines. Author

A91-56249

PRECOMBUSTION SHOCK WAVE AS A MEANS OF THE WORKING PROCESS CONTROL IN A SUPERSONIC COMBUSTION CHAMBER

S. I. BARANOVSKII and V. M. LEVIN (Moskovskii Aviatsonnyi Institut, Moscow, USSR) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Supplementary Papers. Bristol, England, Rolls-Royce, PLC, 1991, 6 p. refs

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A technique is presented for the complex study of a supersonic flow with throttling and burning utilizing small-size measuring probes. Details of the experimental setup are presented whereby gaseous hydrogen is axially fed by means of a gas generator placed in the plenum, into the combustion chamber through a conical nozzle at the exit plane. Test results show the characteristic distribution of static pressure over the initial segment of the combustion chamber at the heat addition and the mechanical throttling. R.E.P.

A91-56359

VIBRATION OF MISTUNED BLADED DISKS SUPPORTED BY FLEXIBLE CONTINUOUS SHAFTS

N. KHADER and S. MASOUD (Jordan University of Science and Technology, Irbid) Journal of Sound and Vibration (ISSN 0022-460X), vol. 149, Sept. 22, 1991, p. 471-488. refs

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A simple structural model is presented to investigate the effect of blade mistuning on the dynamic characteristics of a non-rotating flexible blade - rigid disk - flexible shaft assembly, which resembles a fan stage of a modern gas turbine engine. Each blade is allowed both in-plane and out-of-plane deformations with respect to the disk hub, and the supporting shaft is free to bend in two planes. Lagrange's equation is used with the assumed mode method to derive the governing equations of motion. It is shown that blade mistuning strongly affects the interaction between flexible bladed disk (on rigid shaft) and rigid bladed disk (on flexible shaft) modes. This interaction affects the flexible bladed disk modes with all possible nodal diameters, and it is not restricted to the modes with one nodal diameter, as observed for the tuned bladed disks, supported by a flexible shaft. Results are presented for a mistuned seven-bladed disk attached at the free end of a cantilever shaft in one case, and a simply supported shaft with an overhang in another. Author

A91-56365* Toledo Univ., OH.

FINITE ELEMENT ELASTIC-PLASTIC-CREEP AND CYCLIC LIFE ANALYSIS OF A COWL LIP

V. K. ARYA (Toledo, University, OH), M. E. MELIS, and G. R. HALFORD (NASA, Lewis Research Center, Cleveland, OH) Fatigue and Fracture of Engineering Materials and Structures (ISSN 8756-758X), vol. 14, no. 10, 1991, p. 967-977. Previously announced in STAR as N90-22808. refs

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Results are presented of elastic, elastic-plastic and elastic-plastic-creep analyses of a test-rig component of an actively cooled cowl lip. A cowl lip is part of the leading edge of an engine inlet of proposed hypersonic aircraft and is subject to severe thermal loadings and gradients during flight. Values of stresses calculated by elastic analysis are well above the yield strength of the cowl lip material. Such values are highly unrealistic, and thus elastic stress analyses are inappropriate. The inelastic (elastic-plastic and elastic-plastic-creep) analyses produce more reasonable and acceptable stress and strain distributions in the component. Finally, using the results from these analyses, predictions are made for the cyclic crack initiation life of a cowl lip. A comparison of predicted cyclic lives shows the cyclic life prediction from the elastic-plastic-creep analysis to be the lowest and, hence, most realistic. Author

A91-56629

BACKGROUND RATIONALE FOR TAILORING AIRBORNE EXTERNAL STORES VIBRATION TESTS IN MIL-STD-810, METHOD 514

HANK CARUSO (Westinghouse Product Qualification Laboratory, Baltimore, MD) IES, Journal (ISSN 1052-2883), vol. 34, Sept.-Oct. 1991, p. 41-45. refs

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Background rationale currently missing from Method 514 (vibration) of MIL-STD-810C/D/E for vibration testing of external stores and associated equipment on jet aircraft (Categories 7A and 7B) is discussed. Attention is given to misapplication of the response threshold in Category 7A as an input spectrum and the level of conservatism factored into the test spectra published in this method. Consideration is given to longitudinal axis vibration test levels compared with vertical and lateral axis test levels, and the appropriate values of dynamic pressure for specific aircraft/store combinations. R.E.P.

A91-56773

ADVANCED COMPOSITES TAKE FLIGHT

STEVEN ASHLEY Mechanical Engineering (ISSN 0025-6501), vol. 113, Oct. 1991, p. 51-56.

Copyright

New automated manufacturing systems developed to produce lightweight, strong, and stiff composite materials for use in the fabrication of the B-2 Stealth bomber's airframe are described along with fatigue tests used in the B-2 bomber program. Particular consideration is given to an air drill with two-speed transmission and an adaptive-control system that can sense the hardness of the material being cut and alter the spindle speed appropriately, a high-speed and high-precision ultrasonic prepreg knife, a robotic drilling assembly, a water-jet trimming procedure, and giant (90-ft by 25-ft) autoclaves built for composite work. Also described is a robotic tape-layering system for manufacturing the B-2 outboard wings. I.S.

A91-56898

COLLIMATED PROJECTION SYSTEMS - MORE REALISTIC FLIGHT SIMULATION

THOMAS L. MARTZALL (McDonnell Douglas Corp., Visual Simulation Systems Div., Saint Louis, MO) Photonics Spectra (ISSN 0731-1230), vol. 25, Sept. 1991, p. 114-116.

Copyright

A review is presented of the Multiview system, a collimated multiple-field-of-view projection method. The system's display provides a cross-cockpit view for flight crew members by utilizing a full-color projection system that puts collimated scene images on a continuous lightweight mirror. As there are no seams in the mirror, nothing detracts from the image, giving the crew a realistic panoramic view that offers a field of view that is 40 deg vertical and 150, 180, 200 or 225 deg horizontal. R.E.P.

N91-31494# Federal Aviation Administration, Atlantic City, NJ.

SOLID-STATE RADAR BEACON DECODER (SSRBD) MASTER TEST PLAN (MTP)

LEONARD H. BAKER and THOMAS D. BRATTON Sep. 1991 37 p

(DOT/FAA/CT-TN91/33) Avail: NTIS HC/MF A03

The Master Test plan (MTP) establishes the basic framework to guide and direct the Solid-State Radar Beacon Decoder (SSRBD) test program. The MTP explains the relationship between all test phases and also concerns the SSRBD system's readiness to be integrated into the National Airspace System (NAS). Sufficient detail is provided to define and direct the development of the next lower level of documentation. The MTP addresses the responsibilities of the SSRBD contractor and the Federal Aviation Administration (FAA). Author

N91-31495# Federal Aviation Administration, Atlantic City, NJ.

AERONAUTICAL MOBILE SATELLITE SERVICE (AMSS) TEST PLAN

SEAN M. SANDLIN (Computerized Technologies, Inc., Columbus,

OH.) May 1991 49 p
(Contract NASA ORDER T-0704-F)
(DOT/FAA/CT-TN91/20) Avail: NTIS HC/MF A03

A test program is described which will be conducted by the Federal Aviation Administration to support the validation of Standards and Recommended Practices being developed for the Aeronautical Mobile Satellite Service by the International Civil Aviation Organization. A description of the Communication Test Facility is also presented which will be used to perform the tests. A brief description is also included of each test to be performed along with setup and data to be recorded. Author

N91-31515 Department of National Defence, Ottawa (Ontario). Directorate Research and Development Air.

TECHNIQUES TO ASSESS THE STATE OF HEALTH OF SEALED LEAD ACID BATTERIES

G. VERVILLE, P. ROBERGE, and J. SMIT (Ottawa Univ., Ontario) 1988 42 p Presented at the 16th International Power Sources Symposium, Bournemouth, England, 26-29 Sep. 1988 (CTN-91-60214) Avail: NTIS HC A03

Internal defects and short-circuit formation are causes of failure in aircraft batteries. Non-destructive investigation techniques which are sensitive to the internal design must be employed to detect these defects. Three techniques, cell impedance measurements, voltage noise measurements and video infrared thermography, are evaluated for this purpose. Thermography was found to be a very cost effective tool. It can be used to detect manufacturing defects when time is of the essence and is helpful in the interpretation of data collected by existing techniques. The use of ac impedance measurements at 1 kHz has been well received by battery shop personnel and has been used to complement the standard voltage measurements in providing advanced warning of potential problems. However, impedance measurements are sensitive to any change in cell design parameters introduced by manufacturers and therefore must be correlated with a specific cell design if they are to be used as a pass/fail criterion. The noise measurement technique appears to be a promising new tool in the interpretation of cell behavior. CISTI

N91-31576* Institute for Computer Applications in Science and Engineering, Hampton, VA.

CONTROL OF OSCILLATORY FORCES ON A CIRCULAR CYLINDER BY ROTATION Final Report

YUH-ROUNG OU Aug. 1991 18 p Submitted for publication (Contract NAS1-18605; AF-AFOSR-0079-89) (NASA-CR-187619; NAS 1.26:187619; ICASE-91-67) Avail: NTIS HC/MF A03 CSCL 20/4

The temporal development of forces acting on a rotating cylinder is investigated numerically in response to a variety of time-dependent rotation rates. Solutions are presented for several types of rotation that illustrate significant effects of the rotation rate on lift, drag, and lift/drag coefficients. Of special interest is the formulation of an optimal control problem for the case of constant speed of rotation. Researchers found an optimal rate that achieves the maximum value of time-averaged lift/drag ratio. Author

N91-31579# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Dept.

DEVELOPMENT OF AN ADVANCED PANEL METHOD FOR COMPLEX CONFIGURATIONS IN SUBSONIC COMPRESSIBLE FLOW; APPLICATION TO THE COMPUTATION OF THE POTENTIAL FLOW THROUGH DUCTS

C. M. VANBEEK 19 Jan. 1987 48 p (Contract NIVR-RB-3111-01201N) (NLR-TR-88001-U; ETN-91-99658; AD-B153564L) Avail: NTIS HC/MF A03

The application of a boundary integral or panel method to duct flows is described. The method is capable of computing the three dimensional, steady state, subsonic, linearized (Prandtl-Glauert) potential flow about general configurations. The method is characterized by the application of a Dirichlet boundary condition and of compressible source and doublet distributions

which are directly applied in the physical space. The geometry of the nonbranching duct (one inflow and one outflow cross section) may be arbitrary as long as the requirements for using the Prandtl-Glauert equation are met. A description of the method is given and three examples of application are presented with emphasis on the investigation of the conservation of mass flow through the ducts. ESA

N91-31584# Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches en Aerothermodynamique.

THREE DIMENSIONAL SHEAR FLOW: FLOW VISUALISATION AROUND A HIGHLY SWEEP BACK AND HIGH INCIDENCE WING Final Report [ECOULEMENTS CISAILLES TRIDIMENSIONNELS: VISUALISATION DE L'ECOULEMENT AUTOUR D'UNE AILE A FORTE FLECHE ET FORTE INCIDENCE]

G. PAILHAS Mar. 1990 20 p In FRENCH (Contract STPA-85-95-004/46) (ONERA-RT-35/5025-28; ETN-91-99914) Avail: NTIS HC/MF A03

A study to find a geometric profile position (sweep 60 degrees fixed, variable incidence) such that the vicinity of the wing body junction becomes a likely field for a horseshoe type turbulent motion, as found in the classical case of the straight wing, is presented. Cavitation flow visualizations by viscous coatings were carried out at incidences of 15, 20, 25, and 30 degrees. Results showed differences in the flows at the wing-body vicinity of differing swept back wings and straight wings. ESA

N91-31586# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.

COMPRESSIBLE TWO DIMENSIONAL BOUNDARY LAYER STRONG PERFECT FLUID COUPLING IN THE CASE OF SHARP LEADING EDGE PROFILES. STATIONARY CASE [COUPLAGE FORT FLUIDE PARFAIT COUCHE LIMITE 2D COMPRESSIBLE DANS LE CAS DES PROFILS A BORD D'ATTAQUE AIGU. CAS STATIONNAIRE]

C. SOIZE May 1990 61 p In FRENCH (ONERA-RT-42/1621-RY-093-R; ETN-91-99935) Avail: NTIS HC/MF A04

Developments in studies of aeroelasticity of blade grids are presented. The final objective is the development of a compressible steady and unsteady two dimensional code for isolated profiles and blade grids. Validation of the steady part and the isolated profile of this code is presented based on mathematical models and numerical analysis. The approach is based on a perfect fluid strong coupling boundary layer method. The resolution method is made in nonstructured finite element mesh with an implicit time scheme. ESA

N91-31590# Association Aeronautique et Astronautique de France, Paris.

FLOW VISUALIZATION AND SIMULATION [VISUALISATION ET SIMULATIONS D'ECOULEMENTS]

A. NAIM, T. PRE, and T. CHEVALIER (Avions Marcel Dassault-Breguet Aviation, Saint-Cloud, France) 1989 23 p In FRENCH Presented at the 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A91-19589 (AAAF-NT-89-18; ISBN-2-7170-0951-5; ISSN-0243-0177; ETN-91-99959) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

The development of interactive visualization tools for the study of aircraft models is examined. The philosophy underlying the development of interactive hardware is elaborated, and attention is given to types of available visualizations and visualization limits. Features of the image analysis and animation techniques in this domain are discussed. ESA

N91-31593# Association Aeronautique et Astronautique de France, Paris.

THE DEVELOPMENT OF A SPECIFIC IMAGE ANALYSIS TECHNIQUE FOR EXPLOITING FLOW VISUALIZATION NEGATIVES [SUR LA MISE AU POINT D'UNE TECHNIQUE SPECIFIQUE D'ANALYSE D'IMAGE POUR L'EXPLOITATION DE CLICHES DE VISUALISATION D'ECOULEMENTS]

ALAIN TEXIER, M. F. COLLIN, and MADELAINE COUTANCEAU (Poitiers Univ., France) 1989 23 p In FRENCH Presented at the 26th Colloque d'Aerodynamique Appliquee, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A91-19583

(AAAF-NT-89-26; ISBN-2-7170-0959-0; ISSN-0243-0177; ETN-91-99967) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

An automatic flow visualization analysis chain was developed with the aim of providing sufficient experimental data indispensable for new numerical models. The chain consists of an image reading component and a processing system for the read data. Algorithms for the analysis chain are described and applied to unsteady nonviscous flow visualizations of a NACA 0012 airfoil at 30 degree high incidence and Reynolds number 3000. The recognition, interpretation and data segmentation algorithms are operational and give good results. ESA

N91-31594# Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Paris (France).

NUMERICAL SIMULATION OF THREE DIMENSIONAL UNSTEADY FLOW BY MULTIPROCESSOR SOLVING OF THE NAVIER-STOKES EQUATIONS Final Summary Report [SIMULATION NUMERIQUE D'ECOULEMENTS INSTATIONNAIRES TRIDIMENSIONNELS PAR RESOLUTION DES EQUATIONS DE NAVIER-STOKES SUR UN SYSTEME MULTIPROCESSEUR]

TAPHUOC LOC, W. LABIDI, ANNIE DULIEU, MADELAINE COUTANCEAU, G. PINEAU, and ALAIN TEXIER (Poitiers Univ., France) Sep. 1990 163 p In FRENCH (Contract DRET/LIMSI-88-047)

(ETN-91-99974) Avail: NTIS HC/MF A08

Results obtained in numerical and experimental studies of the unsteady flows of an incompressible viscous fluid around an infinite span circular cylinder or profile (2-D problem) and around finite span circular cylinder between two walls (3-D problem) are presented. The Cray2 and VP200 vector computers were used for numerical simulation, the LIMSI software for image processing and a fluid mechanics laboratory for visualization experiments. The algorithm is adapted to external and internal flows and uses the velocity-vortex vector. ESA

N91-31595*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A RELATIVE-INTENSITY TWO-COLOR PHOSPHOR THERMOGRAPHY SYSTEM

N. RONALD MERSKI Sep. 1991 32 p (NASA-TM-104123; NAS 1.15:104123) Avail: NTIS HC/MF A03 CSCL 20/4

The NASA LaRC has developed a relative-intensity two-color phosphor thermography system. This system has become a standard technique for acquiring aerothermodynamic data in LaRC Hypersonic Facilities Complex (HFC). The relative intensity theory and its application to the LaRC phosphor thermography system is discussed along with the investment casting technique which is critical to the utilization of the phosphor method for aerothermodynamic studies. Various approaches to obtaining quantitative heat transfer data using thermographic phosphors are addressed and comparisons between thin-film data and thermographic phosphor data on an orbiter-like configuration are presented. In general, data from these two techniques are in good agreement. A discussion is given on the application of phosphors to integration heat transfer data reduction techniques (the thin film method) and preliminary heat transfer data obtained on a

calibration sphere using thin-film equations are presented. Finally, plans for a new phosphor system which uses target recognition software are discussed. Author

N91-31603# Poitiers Univ. (France). Lab. de Mecanique des Fluides.

AUTOMATIC ANALYSIS OF VISUALIZATION NEGATIVES Summary Report [ANALYSE AUTOMATISEE DE CLICHES DE VISUALISATIONS D'ECOULEMENTS]

MARIE-FRANCE COLLIN, MADELAINE COUTANCEAU, ALAIN TEXIER, ANNIE DULIEU, and TAPHUOC LOC (Laboratoire d'Informatique pour la Mecanique et les Sciences de l'Ingenieur, Paris, France) Mar. 1990 60 p In FRENCH (Contract DRET-87-212)

(ETN-91-99971) Avail: NTIS HC/MF A04

An automatic system to quantitatively exploit flow visualization negatives obtained with individualized solid tracers with a view to unsteady inviscid flow analysis is proposed. The system is tested on the flow around a NACA 012 airfoil at 30 degree incidence submitted to an impulsive start. The analysis chain consists of an image reader and processing system. The possibility of analyzing three dimensional flow is considered. ESA

N91-31629# Florida State Univ., Tallahassee. Coll. of Engineering.

UNSTEADY FLOW PAST AN AIRFOIL PITCHING AT A CONSTANT RATE

C. SHIH, L. M. LOURENCO, L. VANDOMMELEN, and A. KROTHAPALLI In VKI, Laser Velocimetry, Volume 2 25 p 1991 Sponsored by AFOSR

Copyright Avail: NTIS HC/MF A10

The unsteady flow past a NACA 0012 airfoil in pitching up motion is experimentally investigated in a water towing tank using the Particle Image Displacement Velocimetry (PIDV) technique. The Reynolds number, based on the airfoil chord and the freestream velocity, is 5000. The airfoil pitching motion is from 0 to 30 degrees angle of attack at a dimensionless pitch rate alpha of 0.131. Instantaneous velocity fields at different times were acquired over the entire flow field. Using the whole field data, the out of plane component of vorticity is computed. The following features are observed. Boundary layer separation near the airfoil leading edge leads to the formation of a vortical structure. The evolution of this vortex along the upper surface dominates the aerodynamic performance of the airfoil. Complete stall emerges when the boundary layer near the leading edge detaches from the airfoil, under the influence of the vortex. The vortex further triggers the shedding of a counter rotating vortex near the trailing edge. A parallel computational study using the discrete vortex, random walk approximation was conducted. In general, the computational results agree very well. ESA

N91-31654*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

RECENT MANUFACTURING ADVANCES FOR SPIRAL BEVEL GEARS

ROBERT F. HANDSCHUH and ROBERT C. BILL (Army Aviation Systems Command, Cleveland, OH.) 1991 14 p Presented at the Aerotech 1991, Long Beach, CA, 23-26 Sep. 1991; sponsored by SAE

(Contract DA PROJ. 1L1-62211-A-47A)

(NASA-TM-104479; E-6326; NAS 1.15:104479; AVSCOM-TR-91-C-022) Avail: NTIS HC/MF A03 CSCL 13/9

The U.S. Army Aviation Systems Command (AVSCOM), through the Propulsion Directorate at NASA LRC, has recently sponsored projects to advance the manufacturing process for spiral bevel gears. This type of gear is a critical component in rotary-wing propulsion systems. Two successfully completed contracted projects are described. The first project addresses the automated inspection of spiral bevel gears through the use of coordinate measuring machines. The second project entails the computer-numerical-control (CNC) conversion of a spiral bevel gear grinding machine that is used for all aerospace spiral bevel gears.

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The results of these projects are described with regard to the savings effected in manufacturing time. Author

N91-31679* Rensselaer Polytechnic Inst., Troy, NY. Dept. of Mechanical Engineering, Aeronautical Engineering and Mechanics.

STATIC STRAIN AND VIBRATION CHARACTERISTICS OF A METAL SEMIMONOCOQUE HELICOPTER TAIL CONE OF MODERATE SIZE Final Report

RICHARD L. BIELAWA, RACHEL E. HEFNER, and ANDRE CASTAGNA Jun. 1991 128 p

(Contract NAG1-807; DAAG29-82-K-0093; NSF MSM-88-06257) (NASA-CR-187576; NAS 1.26:187576) Avail: NTIS HC/MF A07 CSDL 20/11

The results are presented of an analytic and experimental research program involving a Sikorsky S-55 helicopter tail cone directed ultimately to the improved structural analysis of airframe substructures typical of moderate sized helicopters of metal semimonocoque construction. Experimental static strain and dynamic shake-testing measurements are presented. Correlation studies of each of these tests with a PC-based finite element analysis (COSMOS/M) are described. The tests included static loadings at the end of the tail cone supported in the cantilever configuration as well as vibrational shake-testing in both the cantilever and free-free configurations. Author

N91-31687* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

IMPROVED FINITE-ELEMENT METHODS FOR ROTORCRAFT STRUCTURES

HOWARD E. HINNANT Aug. 1991 27 p

(Contract DA PROJ. 1L1-61102-AH-45C) (NASA-TM-104104; NAS 1.15:104104; AVSCOM-TR-91-B-006) Avail: NTIS HC/MF A03 CSDL 20/11

An overview of the research directed at improving finite-element methods for rotorcraft airframes is presented. The development of a modification to the finite element method which eliminates interelement discontinuities is covered. The following subject areas are discussed: geometric entities, interelement continuity, dependent rotational degrees of freedom, and adaptive numerical integration. This new methodology is being implemented as an anisotropic, curvilinear, p-version, beam, shell, and brick finite element program. Author

N91-32048* Kawasaki Heavy Industries Ltd., Gifu (Japan).

THE ROLE OF COMPUTATIONAL FLUID DYNAMICS IN AERONAUTICAL ENGINEERING (8): A MIXED COMPRESSION INLET FOR A SUPERSONIC AIRPLANE

AKIRA FUJIMOTO, NOBUO NIWA, and KEISUKE SAWADA (Tohoku Univ., Sendai, Japan) In National Aerospace Lab., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 121-126 Nov. 1990 In JAPANESE; ENGLISH summary

Avail: NTIS HC/MF A14

A numerical investigation of a supersonic mixed-compression inlet is carried out. The inlet is designed for Mach 2.5 by applying the Method of Characteristics. Realistic ramp bleed and throat bypass systems are simulated by a two-dimensional, finite volume, multiblock Total Variation Diminishing (TVD) Navier-Stokes code. From the calculations, the roles of ramp bleed and throat bypass systems are revealed. The mechanism for improving the pressure recovery ahead of an inlet upstart is found for the first time in detail. The results show that the throat gap, or slot, constructs an optimum equivalent wall configuration automatically by the flow conditions around the systems. This result can be obtained because of the great advantage of the computational fluid dynamics (CFD) approach. Author

N91-32063* Tohoku Univ., Sendai (Japan). Dept. of Mechanical Engineering.

NUMERICAL TURBULENT SIMULATIONS OF UNSTEADY TRANSONIC CASCADE FLOWS

SATORU YAMAMOTO, HISAAKI DAIGUJI, and KOUICHI

ISHIZAKA In National Aerospace Lab., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 215-220 Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

A numerical simulation of unsteady turbulent flows through a supersonic compressor cascade is presented. The fundamental equations used are the compressible Navier-Stokes equations of contravariant velocities and two equation kappa epsilon turbulence model. These equations are numerically discretized by the implicit time marching method in which some efficient numerical schemes are used. Some of them are the Newton iterative algorithm for unsteady calculation, a new shock capturing scheme for obtaining oblique shocks more sharply and a numerical technique, so called know how to simulate the turbulent transition due to the shocks. In addition to the numerical schemes, a numerical simulator was developed to make the animation during the flow calculation by using a graphic workstation. This system is also introduced. Author

N91-32064* National Aerospace Lab., Tokyo (Japan).

UNSTEADY FLOW ANALYSIS IN TWO-DIMENSIONAL COMPRESSOR CASCADE

MASAHIRO FUKUDA, KAZUO KIKUCHI, ATSUSHIRO TAMURA, KEISUKE HASHIMOTO, and AKINORI MATSUOKA (Kawasaki Heavy Industries Ltd., Kamagihara, Japan) In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 221-226 Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

The unsteady flow field with large separation in highly loaded transonic compressor cascade is numerically analyzed by the implicit time marching method which also solves 2-D Navier-Stokes equations. It is effective for the aerodynamic design of improved compressor cascade which makes possible accurate prediction of aerodynamic performances such as total pressure loss or exit flow angle, even those with large boundary layer separation. Several computational trials are studied, including the unsteady simulation without using thin layer approximation or any turbulence models. Author

N91-32069* National Aerospace Lab., Tokyo (Japan).

APPLICATION OF 3-D NAVIER-STOKES COMPUTATION TO TURBINE VANE DESIGN

KAZUO KIKUCHI, OSAMU NOZAKI, ATSUSHIRO TAMURA, KOJI MATSUNAGA, HISAO TAKEUCHI, TAKASI MAYA, and RURIKO YAMAWAKI (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo, Japan) In its Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics p 249-255 Nov. 1990 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A14

An application of the 3-D Navier-Stokes computations in designing a turbine vane cascade is presented. The accurate prediction of the cascade flow characteristics such as total pressure loss and outlet flow angle is important for aerodynamic engineers to evaluate the performance of airfoil contour shapes. A curvilinear leaned stator vane, adopted to suppress the secondary flow and reduce the losses, is studied in detail. The advanced design based on the 3-D Navier-Stokes computations succeeded to reduce the losses greatly showing the capability of a code as a design tool. Author

N91-32282* Federal Aviation Administration, Atlantic City, NJ. **SATELLITE DATA LINK VALIDATION TEST PLAN Technical Report, Dec. 1989 - Oct. 1990**

HILDA M. DIMEO Sep. 1991 19 p

(Contract NASA ORDER T-0704F) (DOT/FAA/CT-TN91/6) Avail: NTIS HC/MF A03

The validation process of a satellite data link is described. Aircraft equipped with satellite communication avionics will relay progress reports through a satellite to a ground earth station (GES). These will be compared directly to voice reports made using high-frequency (HF) radio. The results of the comparisons between the different links will be used to determine the suitability of satellite

communication as a replacement for HF for oceanic air traffic control. Author

N91-32283# Federal Aviation Administration, Atlantic City, NJ.
DATA MULTIPLEXING NETWORK (DMN), PHASE 3:
EQUIPMENT OPERATIONAL TEST AND EVALUATION
(OT&E)/INTEGRATION TEST PLAN
 WAYNE BELL Oct. 1991 64 p
 (DOT/FAA/CT-TN91/24) Avail: NTIS HC/MF A04

The presented plan addresses the Operational Test and Evaluation (OT&E)/Integration testing of the Data Multiplexing Network (DMN) equipment in the current NAS environment. The approach and concept is to conduct integration tests with appropriate National Airspace System (NAS) systems to verify that NAS requirements and DMN specifications and Statistical Multiplexer requirements were satisfied. This will be accomplished by conducting unit level tests at the Federal Aviation Administration (FAA) Technical Center and extensive integration tests at the key test sites of Albuquerque, New Mexico; Denver, Colorado; and Minneapolis, Minnesota Air Route Traffic Control Centers (ARTCC). The DMN equipment being procured includes Deterministic Time Division Multiplexing (DTDM) Commercial Off-The-Shelf (COTS) equipment and the NON-COTS equipment (a/b switch and clock box). This plan describes the test program for the DTDM COTS equipment. Author

N91-32284# Wichita State Univ., KS. Inst. for Aviation Research.
ELECTROMAGNETIC EMISSIONS FROM AN
ELECTRO-IMPULSE DEICING SYSTEM IN A COMPOSITE
WING EQUIPPED WITH LIGHTNING PROTECTION
 G. W. ZUMWALT Sep. 1991 27 p
 (Contract DTEA03-89-P-01022)
 (DOT/FAA/CT-TN90/32) Avail: NTIS HC/MF A03

Electromagnetic interference (EMI) accompanying the use of the Electro-Impulse Deicing (EIDI) system was investigated in 1988 and 1989. Results indicated that EIDI emissions inside aluminum wings were almost totally shielded, but EIDI inside composite wings produced emissions exceeding permissible levels unless shielding and grounding was provided for all components. However, lightning protection for composite wings require a fine mesh copper screen grid to be embedded in the composite. The questions arose concerning the shielding effect of this screen, to see if it would significantly reduce EMI from EIDI. Emissions tests were conducted on two similar composite wing leading edges with EIDI installed; one had a lightning protection grid. The results were negative; the embedded lightning protection wire added negligible shielding at all frequencies to the composite leading edge. Author

N91-32440*# National Aeronautics and Space Administration.
 Lewis Research Center, Cleveland, OH.
A LASER VELOCIMETER INVESTIGATION OF THE NORMAL
SHOCK-WAVE BOUNDARY LAYER INTERACTION Ph.D.
Thesis, Toledo Univ.
 RANDALL M. CHRISS Sep. 1991 123 p
 (NASA-TM-105201; E-6504; NAS 1.15:105201) Avail: NTIS
 HC/MF A06 CSDL 20/4

Nonintrusive 3-D measurements were made of a normal shock wave/turbulent boundary layer interaction. The measurements were made through a quadrant of a square test section of a continuous flow supersonic wind tunnel in which a normal shock wave had been stabilized. Two dimensional measurements were made throughout the interaction region while 3-D measurements were made near the corner in the vicinity of the shock where 3-D flow effects were expected to be significant. Laser Doppler velocimetry, surface static pressure measurements, and flow visualization techniques were used for two freestream nominal Mach number test cases: 1.6 and 1.3. No turbulence information was obtained. The mean velocity measurements were converted to Mach number by recording the wind tunnel total temperature. Some shock oscillation was present during both of the test cases. After startup of the wind tunnel, the shock oscillated with an amplitude of approx. + or - 1 cm, however, after reaching steady condition, the shock

oscillation amplitude was greatly reduced, as evidenced by the laser velocimeter results. The Mach 1.3 test case resulted in a nearly uniform flow without secondary shock waves and with no or very isolated corner separation. Author

N91-32441*# North Carolina State Univ., Raleigh.
AN APPROXIMATE VISCOUS SHOCK LAYER TECHNIQUE
FOR CALCULATING CHEMICALLY REACTING HYPERSONIC
FLOWS ABOUT BLUNT-NOSED BODIES
 F. MCNEIL CHEATWOOD and FRED R. DEJARNETTE Aug.
 1991 195 p
 (Contract NCC1-100)
 (NASA-CR-187617; NAS 1.26:187617) Avail: NTIS HC/MF A09
 CSDL 20/4

An approximate axisymmetric method was developed which can reliably calculate fully viscous hypersonic flows over blunt nosed bodies. By substituting Maslen's second order pressure expression for the normal momentum equation, a simplified form of the viscous shock layer (VSL) equations is obtained. This approach can solve both the subsonic and supersonic regions of the shock layer without a starting solution for the shock shape. The approach is applicable to perfect gas, equilibrium, and nonequilibrium flowfields. Since the method is fully viscous, the problems associated with a boundary layer solution with an inviscid layer solution are avoided. This procedure is significantly faster than the parabolized Navier-Stokes (PNS) or VSL solvers and would be useful in a preliminary design environment. Problems associated with a previously developed approximate VSL technique are addressed before extending the method to nonequilibrium calculations. Perfect gas (laminar and turbulent), equilibrium, and nonequilibrium solutions were generated for airflows over several analytic body shapes. Surface heat transfer, skin friction, and pressure predictions are comparable to VSL results. In addition, computed heating rates are in good agreement with experimental data. The present technique generates its own shock shape as part of its solution, and therefore could be used to provide more accurate initial shock shapes for higher order procedures which require starting solutions. Author

N91-32442*# Duke Univ., Durham, NC. Dept. of Mechanical Engineering and Materials Science.
CALCULATION OF UNSTEADY LINEARIZED EULER FLOWS
IN CASCADES USING HARMONICALLY DEFORMING GRIDS
 KENNETH C. HALL and WILLIAM S. CLARK 1991 18 p
 (Contract NAG3-1192)
 (NASA-CR-188916; NAS 1.26:188916) Avail: NTIS HC/MF A03
 CSDL 20/4

A method for calculating unsteady, inviscid, compressible flows in cascades is presented. Using the linearized Euler technique, the flow is decomposed into a steady or mean flow plus a harmonically varying small disturbance flow. The equations that describe the small disturbance flow are linear variable coefficient equations, and are solved using a pseudo-time time marching Lax-Wendroff technique. Unlike previous linearized methods, however, the solution is computed on a harmonically deforming computational grid that conforms to the motion of the vibrating airfoils. The mean flow and perturbation flow solutions are defined in the deforming coordinate system rather than in a coordinate system fixed in space. Hence, no extrapolation terms are required to implement the upwash boundary conditions at the airfoil surfaces, significantly improving the accuracy of the method. For transonic flow calculations, unsteady shock motions are modelled using shock capturing. The unsteady loads due to the shock motion are then seen as pressure impulses. Representative computational results are presented for transonic channel flows and subsonic and transonic cascade flows. Author

N91-32445# Centre d'Etudes et de Recherches, Toulouse (France). Complexe Scientifique de Rangueil.
CALCULATION OF TURBULENT COMPRESSIBLE FLOWS
 J. COUSTEIX /In AGARD, Appraisal of the Suitability of Turbulence Models in Flow Calculations 20 p Jul. 1991

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The use and the suitability is discussed of turbulence models for calculating compressible flows in aerodynamics. As the compressible form of turbulence models is generally extended from a basic incompressible form, the emphasis is placed on the pertinence of these extensions and on the peculiarities of compressible flows. Author

N91-32449# Turkish Aerospace Industries, Ankara.

COMPUTATIONAL TURBULENCE STUDIES IN TURKEY

UNVER KAYNAK *In* AGARD, Appraisal of the Suitability of Turbulence Models in Flow Calculations 8 p Jul. 1991

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Applications of various turbulence models to different flow problems that were recently carried out in Turkey are presented. Navier-Stokes, boundary layer, and vorticity stream function methods are used to solve 2-D or 3-D steady and/or unsteady flow problems. Examples are given in low speed and transonic flow regimes for axisymmetric bodies, airfoils, rigid ripples, and jet flows. Different turbulence models are used such as algebraic, half equation, and k-epsilon models. It is shown that improved accuracies can be obtained by using the so-called half equation (nonequilibrium) turbulence model for some 3-D configurations. Suitability of different turbulence models is explored for a variety of flow cases such as dynamic stall, jets in crossflow, and oscillatory boundary layers. Author

N91-32463*# Institute for Computer Applications in Science and Engineering, Hampton, VA.

AN APPROXIMATE RIEMANN SOLVER FOR HYPERVELOCITY FLOWS Final Report

PETER A. JACOBS Sep. 1991 16 p Submitted for publication

(Contract NAS1-18605)

(NASA-CR-187629; NAS 1.26:187629; ICASE-91-75) Avail: NTIS HC/MF A03 CSDL 20/4

We describe an approximate Riemann solver for the computation of hypervelocity flows in which there are strong shocks and viscous interactions. The scheme has three stages, the first of which computes the intermediate states assuming isentropic waves. A second stage, based on the strong shock relations, may then be invoked if the pressure jump across either wave is large. The third stage interpolates the interface state from the two initial states and the intermediate states. The solver is used as part of a finite-volume code and is demonstrated on two test cases. The first is a high Mach number flow over a sphere while the second is a flow over a slender cone with an adiabatic boundary layer. In both cases the solver performs well. Author

N91-32635*# Federal Aviation Administration, Atlanta, GA.

DESIGNS FOR SURGE IMMUNITY IN CRITICAL ELECTRONIC FACILITIES

EDWARD F. ROBERTS, JR. *In* NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 7 p Aug. 1991

Avail: NTIS HC/MF A99 CSDL 09/3

In recent years, Federal Aviation Administration (FAA) embarked on a program replacing older tube type electronic equipment with newer solid state equipment. This replacement program dramatically increased the susceptibility of the FAA's facilities to lightning related damages. The proposal is presented of techniques which may be employed to lessen the susceptibility of new FAA electronic facility designs to failures resulting from lightning related surges and transients as well as direct strikes. The general concept espoused is one of a consistent system approach employing both perimeter and internal protection. It compares the technique presently employed to reduce electronic noise with other techniques which reduce noise while lowering susceptibility to lightning related damage. It is anticipated that these techniques will be employed in the design of an Air Traffic Control Tower in a high isokeraunic

area. This facility would be subjected to rigorous monitoring over a multi-year period to provide quantitative data hopefully supporting the advantage of this design. Author

N91-32643*# Raychem Ltd., Swindon (England).

LIGHTNING PROTECTION OF FULL AUTHORITY DIGITAL ELECTRONIC SYSTEMS

DAVID CROFTS *In* NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991

Avail: NTIS HC/MF A99 CSDL 09/3

Modern electronic systems are vulnerable to transient and they now provide safety critical functions such as full authority digital electronic control (FADEC) units for fly by wire aircraft. Of the traditional suppression technologies available diodes have gained the wider acceptance, however, they lack the current handling capacity to meet existing threat levels. The development of high speed fold back devices where, at a specified voltage, the off state resistance switches to a very low on state one has provided the equivalent to a semiconductor spark gap. The size of the technology enables it to be integrated into connectors of interconnection cables. To illustrate the performance the technology was developed to meet the Lightning Protection requirements for FADEC units within aeroengines. Work was also carried out to study switching behavior with the waveform 5, the 500 us, 10 kA pulse applied to cable assemblies. This test enabled all the switches in a connector to be fired simultaneously. Author

N91-32694*# Electrical Research Association, Leatherhead (England).

LIGHTNING INDUCED CURRENTS IN AIRCRAFT WIRING USING LOW LEVEL INJECTION TECHNIQUES

E. G. STEVENS and D. T. JORDAN (Royal Aircraft Establishment, Farnborough, England) *In* NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 10 p Aug. 1991

Avail: NTIS HC/MF A20 CSDL 09/3

Various techniques were studied to predict the transient current induced into aircraft wiring bundles as a result of an aircraft lightning strike. A series of aircraft measurements were carried out together with a theoretical analysis using computer modeling. These tests were applied to various aircraft and also to specially constructed cylinders installed within coaxial return conductor systems. Low level swept frequency CW (carrier waves), low level transient and high level transient injection tests were applied to the aircraft and cylinders. Measurements were made to determine the transfer function between the aircraft drive current and the resulting skin currents and currents induced on the internal wiring. The full threat lightning induced transient currents were extrapolated from the low level data using Fourier transform techniques. The aircraft and cylinders used were constructed from both metallic and CFC (carbon fiber composite) materials. The results show the pulse stretching phenomenon which occurs for CFC materials due to the diffusion of the lightning current through carbon fiber materials. Transmission Line Matrix modeling techniques were used to compare theoretical and measured currents. Author

N91-32701*# Centre d'Etudes de Gramat (France).

A THEORETICAL ANALYSIS OF THE ELECTROMAGNETIC ENVIRONMENT OF THE AS330 SUPER PUMA HELICOPTER EXTERNAL AND INTERNAL COUPLING

F. FLOURENS, T. MOREL, D. GAUTHIER, and D. SERAFIN *In* NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 12 p Aug. 1991 Sponsored in part by Direction des Recherches, Etudes et Techniques (DRET)

Avail: NTIS HC/MF A20 CSDL 20/14

Numerical techniques such as Finite Difference Time Domain (FDTD) computer programs, which were first developed to analyze the external electromagnetic environment of an aircraft during a wave illumination, a lightning event, or any kind of current injection, are now very powerful investigative tools. The program called

GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A91-53864*# National Aeronautics and Space Administration, Washington, DC.

TECHNICAL BASES FOR HIGH SPEED CIVIL TRANSPORT ENVIRONMENTAL ACCEPTABILITY

HOWARD L. WESOKY, JOHN R. FACEY, and KEVIN P. SHEPHERD (NASA, Washington, DC) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs

(AIAA PAPER 91-3326) Copyright

Uncertainties concerning atmospheric pollution, airport-community noise, and sonic booms, are the concerns of NASA's High-Speed Research Program. Current analytical predictions are of an operational regime centered on Mach 2.4/20-km altitude where the goal of 5-gm equivalent NO₂ emissions/kg fuel can result in no more than 1-percent column ozone depletion. Jet-noise suppressors using a mixer-ejector device are seen as capable of furnishing substantial noise reduction. Low-boom aerodynamic configurations are under scrutiny to maximize aircraft economic performance through overland supersonic flight. O.C.

A91-54071*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, MD.

THE DYNAMICS OF THE HSCT ENVIRONMENT

ANNE R. DOUGLASS and RICHARD B. ROOD (NASA, Goddard Space Flight Center, Greenbelt, MD) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. refs

(AIAA PAPER 91-3156) Copyright

Assessments of the impact of aircraft engine exhausts on stratospheric ozone levels are currently limited to 2D zonally-averaged models which, while completely representing chemistry, involve high parameterization of transport processes. Prospective 3D models under development by NASA-Goddard will use winds from a data-assimilation procedure; the upper troposphere/lower stratosphere behavior of one such model has been verified by direct comparison of model simulations with satellite, balloon, and sonde measurements. Attention is presently given to the stratosphere/troposphere exchange and nonzonal distribution of aircraft engine exhaust. O.C.

A91-54072*# Aerodyne Research, Inc., Billerica, MA. PLUME AND WAKE DYNAMICS, MIXING, AND CHEMISTRY BEHIND AN HSCT AIRCRAFT

R. C. MIAKE-LYE, M. MARTINEZ-SANCHEZ, R. C. BROWN, and C. E. KOLB (Aerodyne Research, Inc., Billerica, MA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 18 p. refs

(Contract NAS1-19161)

(AIAA PAPER 91-3158) Copyright

The chemical evolution and mixing and vortical motion of a High Speed Civil Transport's engine exhausts must be analyzed in order to track the gas and its speciation as emissions are mixed to atmospheric scales. Attention is presently given to an analytic model of the wake dynamical processes which accounts for the roll-up of the trailing vorticity, its breakup due to the Crow instability, and the subsequent evolution and motion of the reconnected vorticity. The concentrated vorticity is noted to wrap up the buoyant exhaust and suppress its continued mixing and dilution. The species tracked encompass those which could be heterogeneously reactive on the surfaces of the condensed ice particles, and those capable of reacting with exhaust soot particle

GORFF-VE, was extended to compute the inner electromagnetic fields that are generated by the penetration of the outer fields through large apertures made in the all metallic body. Then, the internal fields can drive the electrical response of a cable network. The coupling between the inside and the outside of the helicopter is implemented using Huygen's principle. Moreover, the spectacular increase of computer resources, as calculations speed and memory capacity, allows the modellization structures as complex as these of helicopters with accuracy. This numerical model was exploited, first, to analyze the electromagnetic environment of an in-flight helicopter for several injection configurations, and second, to design a coaxial return path to simulate the lightning aircraft interaction with a strong current injection. The E field and current mappings are the result of these calculations. Author

N91-32716*# United Kingdom Atomic Energy Authority, Culham (England). Lightning Test and Technology. THE NEW SECTION 23 OF DO160C/ED14C LIGHTNING TESTING OF EXTERNALLY MOUNTED ELECTRICAL EQUIPMENT

B. J. C. BURROWS In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 9 p Aug. 1991
Avail: NTIS HC/MF A20 CSCL 09/1

The new Section 23 is introduced which has only very recently been fully approved by the RTCA for incorporation into the first revision of DO160C/ED14C. Full threat lightning direct effects testing of equipment is entirely new to DO160, the only existing lightning testing is transient testing for LRU's (Line Replaceable Units) by pin or cable bundle injection methods, for equipment entirely contained within the airframe and assumed to be unaffected by direct effects. This testing required transients of very low amplitude compared with lightning itself, whereas the tests now to be described involve full threat lightning testing, that is using the previously established severe parameters of lightning appropriate to the Zone, such as 200 kA for Zone 1A as in AC20-136. Direct effects (i.e., damage) testing involves normally the lightning current arc attaching to the object under test (or very near to it) so submitting it to full potential for the electric, mechanical, thermal and shock damage which is caused by high current arcing. Since equipment for any part of the airframe require qualification, tests to demonstrate safety of equipment in fuel vapor regions of the airframe are also included. Author

N91-32719*# Voeikov Main Geophysical Observatory, Leningrad (USSR).

ON ERROR SOURCES DURING AIRBORNE MEASUREMENTS OF THE AMBIENT ELECTRIC FIELD

B. F. EVTEEV In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 11 p Aug. 1991
Avail: NTIS HC/MF A20 CSCL 09/1

The principal sources of errors during airborne measurements of the ambient electric field and charge are addressed. Results of their analysis are presented for critical survey. It is demonstrated that the volume electric charge has to be accounted for during such measurements, that charge being generated at the airframe and wing surface by droplets of clouds and precipitation colliding with the aircraft. The local effect of that space charge depends on the flight regime (air speed, altitude, particle size, and cloud elevation). Such a dependence is displayed in the relation between the collector conductivity of the aircraft discharging circuit - on one hand, and the sum of all the residual conductivities contributing to aircraft discharge - on the other. Arguments are given in favor of variability in the aircraft electric capacitance. Techniques are suggested for measuring from factors to describe the aircraft charge. Author

surfaces to form active contrail and/or cloud condensation nuclei.
O.C.

A91-54073#**HETEROGENEOUS CHEMISTRY AND CLOUDS IN THE HSCT ENVIRONMENT**

M. A. TOLBERT, B. G. KOEHLER, A. M. MIDDLEBROOK, J. A. MANION, I. S. JAYAWEERA, and D. M. GOLDEN (SRI International, Menlo Park, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p. refs

(AIAA PAPER 91-3159) Copyright

Results are presented of laboratory experiments to determine the microphysical and chemical properties of nitric acid and sulfuric acid particulate that may be present in the high-speed civil transport (HSCT) environment. Fourier transform infrared spectroscopy and mass spectrometric techniques are used to study nitric acid/ice films representative of type I polar stratospheric clouds. Three stable stoichiometric hydrates of nitric acid were found: nitric acid monohydrate, dihydrate, and trihydrate. Two distinct crystalline forms of the trihydrate were observed. A Knudsen cell flow reactor is used to study the heterogeneous reactions of ClONO₂ and N₂O₅ on sulfuric acid solutions representative of the global stratospheric aerosol layer. It is shown that the reactivity of ClONO₂ depends strongly on sulfuric acid concentration, with the largest reaction efficiency occurring for the most dilute solution. Some evidence for surface poisoning was observed for the N₂O₅ reaction.
P.D.

A91-54075*# California Univ., Berkeley. Lawrence Berkeley Lab.

SOOT IN THE STRATOSPHERE - THE IMPACT OF CURRENT AND HSCT AIRCRAFT EMISSIONS

A. D. A. HANSEN (Lawrence Berkeley Laboratory, Berkeley, CA), R. F. PUESCHEL, and K. G. SNETSINGER (NASA, Ames Research Center, Moffett Field, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 6 p. refs

(Contract NASA ORDER A-97524-C; DE-AC03-76SF-00098)

(AIAA PAPER 91-3161)

The emission of soot from existing and proposed aircraft and the contribution of this soot to concentrations observed in the troposphere and stratosphere are discussed. The implications of these emissions for issues in stratospheric physics and chemistry are examined. It is argued that, since soot concentrations in the stratosphere exceed those measured in the cleanest regions of the troposphere, it is possible that current aircraft emissions are the dominant source of stratospheric soot. A simple emission/dispersion model is presented that yields an estimate of aircraft contributions which is in agreement with the observations. The soot concentration is found to be too low to cause any detectable direct optical effects. It is estimated that emissions from the proposed fleet of high-speed civil transport stratospheric aircraft will lead to an increase in concentration of soot in the stratosphere by a factor of two or three.
P.D.

N91-31172# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Inst. for Atmospheric Physics.

A DOCUMENTATION OF VERTICAL AND HORIZONTAL AIRCRAFT SOUNDINGS OF ICING RELEVANT CLOUDPHYSICAL PARAMETERS

H.-E. HOFFMANN In AGARD, Low Temperature Environment Operations of Turboengines (Design and User's Problems) 14 p 1990

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In a homogeneous st-cloud (in a high pressure area) the total water content (TWC) is nearly linearly increasing with increasing distance from the cloud base and obtains its largest value near the top (0.39 respectively 0.49 g/cu m). The median volume diameter (MVD) is nearly remaining constant and has predominantly small values (between 15 and 23 microns). The phase of particles

in all st-clouds, evaluated up to now, was fluid. Such a regularity was not found in any of the other types of inhomogeneous clouds of a warm front. Apart from temperature (T), which is decreasing nearly linearly in these clouds too, the course of TWC and MVD is very irregular. Both the parameters can have several maxima at different distances from the base. The maxima values of TWC can be up to 0.45 g/cu m and those of the MVD up to 460 microns. The phase of the particles could vary between fluid and solid. Not only the vertical structures, but also the horizontal structures show great differences in the particle distributions. In the clouds of a high pressure area more than 90 percent of the particles had diameters between 2 and 32 microns.
Author

N91-31751*# National Aeronautics and Space Administration, Washington, DC.

NASA AERODYNAMICS PROGRAM Annual Report, 1990

LOUIS J. WILLIAMS, KRISTIN A. HESSENIUS, MICHAEL DUDLEY, PAMELA F. RICHARDSON, GEORGE UNGER, and STEVE WANDER Aug. 1991 216 p

(Contract NASW-4430)

(NASA-TM-4312; NAS 1.15:4312) Avail: NTIS HC/MF A10

CSCL 04/2

A review of the NASA Aerodynamics Division for FY 1990 is given. The program includes both fundamental and applied research directed at the full spectrum of aerospace vehicles, from rotorcraft to planetary entry probes. Computational methods and applications, computational fluid dynamics validation, transition and turbulence physics, numerical aerodynamic instrumentation, configuration aerodynamics, aeroacoustics, aerothermodynamics, hypersonics, subsonics, fighter aircraft, and rotorcraft are discussed.
Author

N91-32599*# National Aeronautics and Space Administration, John F. Kennedy Space Center, Cocoa Beach, FL.

THE 1991 INTERNATIONAL AEROSPACE AND GROUND CONFERENCE ON LIGHTNING AND STATIC ELECTRICITY, VOLUME 1

Aug. 1991 626 p Conference held in Cocoa Beach, FL, 16-19 Apr. 1991; sponsored in part by NASA, the National Interagency Coordination Group, and Florida Inst. of Tech.

(NASA-CP-3106-VOL-1; NAS 1.55:3106-VOL-1) Avail: NTIS

HC/MF A99 CSCL 04/2

The proceedings of the 1991 International Aerospace and Ground Conference on Lightning and Static Electricity are reported. Some of the topics covered include: lightning, lightning suppression, aerospace vehicles, aircraft safety, flight safety, aviation meteorology, thunderstorms, atmospheric electricity, warning systems, weather forecasting, electromagnetic coupling, electrical measurement, electrostatics, aircraft hazards, flight hazards, meteorological parameters, cloud (meteorology), ground effect, electric currents, lightning equipment, electric fields, measuring instruments, electrical grounding, and aircraft instruments.

N91-32603*# Office National d'Etudes et de Recherches Aerospatiales, Paris (France).

CURRENT WAVE-FORM OBSERVED DURING LIGHTNING STRIKES ON AIRCRAFT

J. L. BOULAY In NASA, Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 12 p Aug. 1991 Previously announced in IAA as A91-45610

Avail: NTIS HC/MF A99 CSCL 04/2

A preliminary validation of a number of mechanisms that can be associated with the various phases encountered during in-flight lightning strikes are provided. It is known that a lightning strike on an aircraft occurs in several phases: a preparation phase, an electric arc attachment phase, a connection phase, and a re-light phase. This analysis is confined to the study of the readings obtained during the electric arc attachment phase and to experiments carried out to validate the scenarios that are currently understood. The objective of the analysis is to explain this attachment phase. A brief review of the experiments that are currently being performed in an attempt to understand the re-light phase is also presented.
Author

N91-32609*# New Mexico Inst. of Mining and Technology, Socorro. Lab. for Atmospheric Research.

ELECTRICAL EMISSIONS OF AIRPLANES FLYING IN ELECTRIFIED CLOUDS AND THEIR EFFECT ON AIRPLANE MEASUREMENTS OF CLOUD ELECTRIC FIELDS

JAMES J. JONES /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 9 p Aug. 1991 Sponsored in part by Navy

(Contract NAG8-751; NSF ATM-82-05468; NSF ATM-82-18621; NSF ATM-86-00526; NSF ATM-89-19697)
 Avail: NTIS HC/MF A99 CSCL 04/2

The signature of the cloud electric field components deduced from measurements made with electric field meters carried on airplane penetrating electrified clouds is often complex, especially when the airplane experiences strong electrical charging. However, simple electric field variations were obtained for penetrations involving severe charging of the airplane on flights over KSC on 19 Aug. 1989. During these episodes of severe electrical charging, the airplane typically became negatively charged as it approached a region of negative cloud charge and then became positively charged as it receded from the cloud charge. The charge acquired by the airplane within the cloud was so large that the electric fields at the faces of the mills mounted on the fuselage were as large as for an ambient electric field of 60 to 80 kV/m. However, the deduced electric field components perpendicular to the direction of flight, to which these mills respond, were only about 5 to 10 kV/m. The variation of the deduced ambient field component in the direction of flight was antisymmetric about the charge region for these penetrations. Analysis of these results suggest that intense plumes of electric charge were emitted from the airplane and that the electric field associated with these plumes overcame the electric field due to the cloud charge at the tail-mounted field mill. As a consequence, the deduced component of the ambient electric field in the direction of flight was severely distorted. These findings emphasize the need for careful evaluation of airplane electric field measurements and of the need for further work on techniques for improving the measurements. Author

N91-32620*# Office National d'Etudes et de Recherches Aérospatiales, Paris (France).

VHF DISCHARGES IN STORM CELLS PRODUCING MICROBURSTS

P. LAROCHE, C. MALHERBE, A. BONDIOU, M. WEBER, C. ENGHOLM, and V. COEL (Massachusetts Inst. of Tech., Lexington.) /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 13 p Aug. 1991 Previously announced in IAA as A91-45637 Sponsored in part by DRET and FAA
 Avail: NTIS HC/MF A99 CSCL 04/2

An experiment was carried out in which 3-D mapping of VHF sources was compared to a 3-D description of the reflectivity and dynamics of associated cloud cells observed by a radar network. Data from 61 microbursts were analyzed and it was found that, in 93 pct. of the cases, electrical activity precedes outflow development. The results confirm that the peak in intracloud activity precedes the maximum value of the outflow. Author

N91-32649*# Office National d'Etudes et de Recherches Aérospatiales, Paris (France). Environnement Electromagnetique.

OBSERVATIONS OF BI-DIRECTIONAL LEADER DEVELOPMENT IN A TRIGGERED LIGHTNING FLASH

P. LAROCHE, V. IDONE, A. EYBERT-BERARD, and L. BARRET (Commissariat a l'Energie Atomique, Grenoble, France) /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 1 10 p Aug. 1991 Previously announced in IAA as A91-45636
 Avail: NTIS HC/MF A99 CSCL 04/2

Observations of a modified form of rocket triggered lightning are described. A flash triggered during the summer of 1989 is studied as part of an effort to model bidirectional discharge. It is suggested that the altitude triggering technique provides a realistic means of studying the attachment process. Author

N91-32705*# United Kingdom Atomic Energy Authority, Culham (England). Lightning Test and Technology.

MEASUREMENTS OF SOME PARAMETERS OF THERMAL SPARKS WITH RESPECT TO THEIR ABILITY TO IGNITE AVIATION FUEL/AIR MIXTURES

S. J. HAIGH, C. J. HARDWICK, and R. E. BALDWIN /In NASA. Kennedy Space Center, The 1991 International Aerospace and Ground Conference on Lightning and Static Electricity, Volume 2 10 p Aug. 1991

Avail: NTIS HC/MF A20 CSCL 04/2

A method used to generate thermal sparks for experimental purposes and methods by which parameters of the sparks, such as speed, size, and temperature, were measured are described. Values are given of the range of such parameters within these spark showers. Titanium sparks were used almost exclusively, since it is particles of this metal which are found to be ejected during simulation tests to carbon fiber composite (CFC) joints. Tests were then carried out in which titanium sparks and spark showers were injected into JP4/(AVTAG F40) mixtures with air. Single large sparks and dense showers of small sparks were found to be capable of causing ignition. Tests were then repeated using ethylene/air mixtures, which were found to be more easily ignited by thermal sparks than the JP4/ air mixtures. Author

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A91-53001

AUTOTESTCON '90; IEEE SYSTEMS READINESS TECHNOLOGY CONFERENCE, SAN ANTONIO, TX, SEPT. 17-20, 1990, CONFERENCE RECORD

Conference sponsored by IEEE. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, 616 p. For individual items see A91-53002 to A91-53056.

Copyright

Various papers on systems readiness technology are presented. Some of the individual topics addressed include: mobile tester switching subsystem architecture, Functional Avionics System Tester, benefits of intelligent support systems, vertical commonality through the use of Ada in ATE systems, CF-18 pATS - ATE on the move, user configuration portable ATE, calibration in portable testers, next generation TPS architecture, dynamic sequencing of test programs, massive monitoring as a methodology to ensure TLM effectiveness, advanced diagnostic architecture for JIAWG compliant designs, enhanced calibration techniques for VXIbus instrumentation, VXI ATE technology, self-improving ATE, software interoperability in VXIbus systems, inductive learning applied to diagnostics, integration techniques for VXIbus instrumentation systems, downsizing with VXIbus, flexible MATE-compliant portable test set, field test collimators for testing FLIR systems, comprehensive design and maintenance environment for test program sets, Graphical ATE Desktop Environment, Ada software support environment for test, interface test adapter configurator, migrating TPSs to next generation ATE, modulator microwave subsystems for downsized TE, VXI-based microwave testing on the flightline, implementing boundary scan test strategies, embedded maintenance subsystem, System Testability Analysis and Research Tool, system testability 'Top Down' apportionment method, analytical techniques for diagnostic functional allocation, hierarchical approach to integrated diagnosis, integrating design for testability and automatic testing approaches, space propulsion systems diagnostics, Mechanical System Condition Monitor system design, engine monitoring system diagnostics for the TF30-P111 engine. C.D.

A91-53010

NEXT GENERATION TPS ARCHITECTURE

ANDREW POON, WILLIAM J. BERTCH, and JAY B. WOOD (General Dynamics Corp., Electronics Div., San Diego, CA) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 51-61. refs

Copyright

The authors describe the symptom-model-based (SMB) approach, which correlates the failure symptom with the ambiguity group using historical data and diagnostic knowledge of the specific line replaceable units (LRUs). The SMB approach incorporates three key techniques for developing a next-generation TPS (test program set) architecture. The first technique is model-based diagnosis, which involves isolating the cause of failure based on the defined structure and functions of the components. Several different techniques and levels of detail for modeling an LRU are considered. The second technique is empirical diagnosis, which involves computing the most probable cause of failure using historical data and results from failure modes and effects analysis (FMEA). The third technique is rule-based diagnosis, which uses the knowledge of experts to isolate failures in an expedient manner. The implementation of each of these techniques is evaluated based on the capability to fault isolate to the correct component, the time to fault isolate, and the complexity of the associated TPS structure. I.E.

A91-53032

INTERFACE TEST ADAPTER CONFIGURATOR

BENNY PHILLIPS (USAF, Software Div., Tinker AFB, OK) and CHARLES BACON (Oklahoma State University, Stillwater) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 255-257.

Copyright

A rule-based system for designing the interface test adapter (ITA) used in automatic testing of the circuit boards of an aircraft's components is described. The design task, known as ITA design, requires significant use of heuristic techniques. The system, called the Interface Test Adapter Configurator (ITA-C), written in Prolog and hosted on a PC, reads in the user-created data file of the test requirements of the circuit board, performs a series of rule-based analyses, optimizes the design, and generates the ITA schematic for fabrication. Although the ITAC is not intended to perform the ITA design at the level of the human experts, it is expected to be a very capable assistant. I.E.

A91-53039

IMPLEMENTING BOUNDARY SCAN TEST STRATEGIES

PETER HANSEN (Teradyne, Inc., Boston, MA) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 325-329. refs

Copyright

Board-level boundary scan testing in the next several years will focus largely on the boundary scan EXTEST mode for structural testing of interconnects between boundary scan devices on a board and testing of conventional, nonscan components which cannot be accessed using traditional in-circuit or cluster test techniques. Strategies and test-nail placement for implementing various types of boundary scan testing are detailed. The strategies discussed are virtual interconnect, virtual in-circuit, standard cluster testing, and virtual cluster testing. It is shown that, where restricted physical access hampers in-circuit or cluster testing, virtual access provided by boundary scan device leads may offer the means of assuring a comprehensive test. When both physical and virtual access is needed, this requirement must be taken into account during board design and factored into board layout to ensure successful implementation of the test. I.E.

A91-53040

HIERARCHICAL BIT - REUSABLE BIT SOFTWARE FOR INTEGRATED SYSTEMS

WAYNE DANIEL and REX SALLADE (Texas Instruments, Inc., Defense Systems and Electronics Group, Plano, TX) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 337-341. refs

Copyright

The authors present a hierarchical BIT (built-in test) implementation for integrated advanced avionics systems to support multiple levels of integration and test. This hierarchical design allows BIT to be reused in several test environments, including module, subsystem, and system test. The authors examine some of the costs, benefits, and tradeoffs made in developing a hierarchical BIT. The hierarchical BIT requirements are discussed. Hardware portability must be addressed by the use of high order languages and a modular design. Varying platforms and test environments must be accommodated by flexible tests which utilize test parameters and generate appropriate results. System reconfigurability must be considered by designing nondeterministic tests which can be executed with limited resources, and the design and configuration management processes should be modified to support the BIT design. I.E.

A91-53043

THE DYNAMICS OF A SUCCESSFUL ENGINEERING SUPPORT EFFORT FOR INTERMEDIATE ATE

DALE A. PARK and ROBERT J. VOLLENTE (USAF, San Antonio Air Logistics Center, TX) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 417-421.

Copyright

The authors address the dynamics of providing effective engineering support for intermediate-level automatic test equipment (ATE). A specific example, the A-10 Intermediate Automatic Test System (A-10 IATS), is used to demonstrate the three phases of a support effort. In phase one, the problem is identified. A determination is made as to length of time support will be required, and the resources required are identified. The support effort is then classified as a project. In phase two, a project leader is selected. This person analyzes the problem. Technical areas of expertise are identified for selection of the engineering support group. With the problem identified and a carefully selected team assembled, problem solution begins. At the end of this phase, the solution will be obtained. In the final phase, the results produced by the management/engineering team are reviewed, and the effectiveness in solving the problem(s) as identified in phase one is evaluated. In the example considered, engineering support improved the mission capability of the A-10 IATS across the Air Force from an average of 24 percent mission capable to 76 percent mission capable in just 5 mo. I.E.

A91-53045

A SYSTEM TESTABILITY 'TOP-DOWN' APPORTIONMENT METHOD

DAVID M. BELLEHSEN, BRIAN A. KELLEY, and ALONY M. HANANIA (Harris Corp., Government Support Systems Div., Syosset, NY) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 451-463. refs

(Contract F30602-87-D-0185)

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The authors present a top-down approach to specifying testability requirements which involves system-level analyses, tradeoffs, and allocation to lower hardware indeture levels. This approach provides guidelines, algorithms, and procedures for computing, assessing, and allocating testability within a new system design. Testability figures of merit (TFOM) used to describe and quantify testability, as applied to a given system, in precise and

measurable engineering terms are presented. Testability allocation methods (TAM) to apportion system testability requirements cost effectively through lower levels of indeture to the replaceable unit level and generate subsystem-level requirements are also given. This allocation process starts with the overall testability requirements of a system and prescribes the distribution of these requirements among the various units constituting the system. The TAM problem is formulated as an optimization problem and solved using the augmented Lagrangian method. The complex interactions between the TFOMs and system performance (reliability, availability, maintainability, and life-cycle cost) are derived using analytical, heuristic, experimental, and historical data. A special case where BIT (built-in test) is the resource to be allocated leads to the top-down BIT prioritization. I.E.

A91-53048

INTEGRATED DIAGNOSIS - A HIERARCHICAL APPROACH

JOHN W. SHEPPARD and WILLIAM R. SIMPSON (Arinc Research Corp., Advanced Research and Development Group, Annapolis, MD) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 477-483. refs Copyright

ARINC's hierarchical model-based approach to integrated maintenance is described. The hierarchical approach is used in the diagnostic aids System Testability and Maintenance Program (STAMP) and Portable Interactive Troubleshooter (POINTER). The information-theoretic approach applied to achieve hierarchical diagnosis is described, and the effectiveness of STAMP and POINTER are described in detail. STAMP and POINTER have the following attributes: the single form of knowledge representation allows all diagnostic elements to function in a consistent manner, regardless of the type or level of maintenance; this knowledge representation can be used for testability analysis, including maintenance architecture and functional packaging; the models are hierarchical, making them easily adaptable to all levels of maintenance; the approach permits diagnosis to be dynamically tailored to the current context; and the models facilitate effective testability assessment, intelligent troubleshooting, and direct links to logistics databases. Thus, STAMP and POINTER, by using the information flow model, permit all aspects of the maintenance process to be addressed using a single method of knowledge representation and a single method of knowledge-base processing. I.E.

A91-53050

AIRLINES GET SMART FOR AVIONICS TESTING

E. M. MELENDEZ (Arinc, Inc., Annapolis, MD) and DAMON C. HART (TYX Corp., Reston, VA) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 505-508. Copyright

The authors present a technical overview of the SMART (Standard Modular Avionics Repair and Test) architecture and discuss some of the test program development and execution features which are expected to improve productivity and lower costs. SMART provides a standard interface for all SMART testers, instrument interchangeability, and a standard ATLAS test language for test programs. It is concluded that SMART's arrival entail big changes in avionics testing for the airlines and substantial benefits to the entire commercial air transport industry. With SMART providing a standardized minimum set of control and support software and an ATE (automatic test equipment) front panel interface, it will now be possible for a rational marketplace of support software and test programming services to emerge. I.E.

A91-53051

INTEGRATING DESIGN FOR TESTABILITY AND AUTOMATIC TESTING APPROACHES

EUGENE A. ESKER, WILLIAM R. SIMPSON, JOHN W. SHEPPARD (Arinc Research Corp., Annapolis, MD), and JEAN-PAUL MARTIN

(Aerospatiale, Toulouse, France) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 509-514. refs Copyright

The Standard Modular Avionics Repair and Test (SMART) concept was developed to provide an approach to standardizing ATE (automatic test equipment) architectures and making the ATE and test program set (TPS) a modular development process. The System Testability and Maintenance Program (STAMP) was developed to meet the need for designing testable systems and verifying the testability of systems. The Portable Interactive Troubleshooter (POINTER) was developed as an intelligent test executive to dynamically manipulate testability models. Using the SMART approach to automatic testing and the STAMP approach to design for testability, an approach for integrating the two with a dynamic tool-POINTER-into a complete architecture for ATE and TPS development is presented. I.E.

A91-53750*# Vigyan Research Associates, Inc., Hampton, VA.

STRUCTURED BACKGROUND GRIDS FOR GENERATION OF

UNSTRUCTURED GRIDS BY ADVANCING FRONT METHOD

SHAHYAR PIRZADEH (Vigyan, Inc., Hampton, VA) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 259-268. refs (Contract NAS1-18585)

(AIAA PAPER 91-3233) Copyright

A new method of background grid construction is introduced for generation of unstructured tetrahedral grids using the advancing-front technique. Unlike the conventional triangular/tetrahedral background grids which are difficult to construct and usually inadequate in performance, the new method exploits the simplicity of uniform Cartesian meshes and provides grids of better quality. The approach is analogous to solving a steady-state heat conduction problem with discrete heat sources. The spacing parameters of grid points are distributed over the nodes of a Cartesian background grid by interpolating from a few prescribed sources and solving a Poisson equation. To increase the control over the grid point distribution, a directional clustering approach is used. The new method is convenient to use and provides better grid quality and flexibility. Sample results are presented to demonstrate the power of the method. Author

A91-54014*# Virginia Polytechnic Inst. and State Univ., Blacksburg.

ADVANCED TRANSPORT DESIGN USING

MULTIDISCIPLINARY DESIGN OPTIMIZATION

JENNIFER BARNUM, CURT BATHRAS, KIRK BEENE, MICHAEL BUSH, GLENN KAUPIN, STEVE LOWE, IAN SOBIESKI, KELLY TINGEN, and DOUGLAS WELLS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 16 p. refs (Contract NAG1-224)

(AIAA PAPER 91-3082) Copyright

This paper describes the results of the first implementation of multidisciplinary design optimization (MDO) techniques by undergraduates in a design course. The objective of the work was to design a civilian transport aircraft of the Boeing 777 class. The first half of the two semester design course consisted of application of traditional sizing methods and techniques to form a baseline aircraft. MDO techniques were then applied to this baseline design. This paper describes the evolution of the design with special emphasis on the application of MDO techniques, and presents the results of four iterations through the design space. Minimization of take-off gross weight was the goal of the optimization process. The resultant aircraft derived from the MDO procedure weighed approximately 13,382 lbs (2.57 percent) less than the baseline aircraft. Author

A91-54016#

USE OF ROBUST CONTROL THEORY IN FLUTTER ANALYSIS

15 MATHEMATICAL AND COMPUTER SCIENCES

GEORGES A. BECUS (Cincinnati, University, OH) and COREY REKOW AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 7 p. Research supported by NSF. refs (AIAA PAPER 91-3085) Copyright

Robust control theory results are applied to the problem of aeroelastic flutter of a system with uncertain structural parameters. After recasting the dynamic aeroelasticity problem in a closed-loop state space form, robustness of an aeroelastic design based on nominal values of structural parameters is predicted, using the stability margins pertaining to multiplicative and additive perturbations in the frequency and/or time domains. This approach provides an alternative to the computationally intensive methods which can be extended to robustness in the presence of uncertain aerodynamic parameters and/or neglected dynamics. The approach is illustrated using a typical wing section example.

O.G.

A91-54017#

CONSIDERATIONS ON LOOP TRANSFER RECOVERY FOR NONMINIMUM PHASE PLANTS

JEWEL B. BARLOW, DIANNE P. O'LEARY (Maryland, University, College Park), and MOGHEN M. MONAHEMI AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (Contract AF-AFOSR-87-0158) (AIAA PAPER 91-3086) Copyright

The purpose of this paper is to elaborate on previous work on obtaining precise-loop-transfer recovery using a reduced-order observer. Specifically, the case is considered in which the plant is nonminimum phase. The mathematical structure for formulation of loop-transfer recovery (LTR) is independent of introducing plant inversion (and/or left or right invertibility) which is required in the Doyle-Stein condition for LTR. In the formulation, the observer dynamic eigenvalues can be chosen arbitrarily and a precise LTR structure can be developed. The structure is totally independent of plant-transmission zeros, both minimum phase and nonminimum phase. For illustration, the technique is applied to three nonminimum phase examples, obtaining precise LTR with high but finite gain.

Author

A91-54022#

AIRCRAFT CONFIGURATION DESIGN CODE PROOF-OF-CONCEPT - DESIGN OF THE CREWSTATION SUBSYSTEM

DANIEL I. NEWMAN (Boeing Co., Helicopters Div., Philadelphia, PA) and JAYDON STANZIONE (Praxis Technologies Corp., Woodbury, NJ) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 15 p. refs (AIAA PAPER 91-3097) Copyright

Research into the application of knowledge-based software to air vehicle system design is reported. The aircraft configuration design code is a software package to independently generate a preliminary configuration layout and loft based upon air vehicle mission role and other top-level parameters. The system architecture, design methodology, and operational crewstation design routine are described. A time and resource analysis of a typical initial design study shows a substantial decrease in project duration with the introduction of an automated design capability.

R.E.P.

A91-54024#

COMPUTER-AIDED CONCEPTUAL DESIGN OF ROTORCRAFT

GARY A. GABRIELE (Rensselaer Polytechnic Institute, Troy, NY) and ASA G. TRAINER AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 12 p. refs (AIAA PAPER 91-3099) Copyright

This paper addresses work in progress toward the development of new methods and tools for the computer-aided conceptual design of rotorcraft. The conceptual design of rotorcraft as practiced in industry was examined by interviewing practicing design engineers.

From this study, an understanding was gained of the tools used by designers; for example, the process by which design artifacts are generated, analyzed and evaluated; and the information resulting from each stage of the design process. In addition, the literature reporting different approaches to computerizing the rotorcraft-design process was reviewed. Issues relating to the applicability of these approaches to the rotorcraft-conceptual-design problem were analyzed. In light of the above, a goal-based design-process model and an object-based design-data model suitable for the rotorcraft-conceptual-design application were proposed and a computer model developed. Interaction between the goal-based process model and object-based data model, and between the overall computer model and the user, were evaluated. The computer model was partially validated by exercising its individual components on a number of representative design problems. An overview of these models and their implementation is presented.

Author

A91-54135

NECESSARY CONDITIONS FOR OPTIMAL DISTURBANCE REJECTION IN LINEAR SYSTEMS

M. B. SUBRAHMANYAM (U.S. Navy, Naval Air Development Center, Warminster, PA) International Journal of Control (ISSN 0020-7179), vol. 54, Oct. 1991, p. 999-1014. refs Copyright

The necessary conditions for a controller to yield maximum disturbance rejection are derived, together with those for maximum disturbance rejection in the case of an observer-based controller. These conditions are noted to be useful in the synthesis of a controller which maximizes the disturbance-rejection capacity of the system. Attention is given to an example connected to H-infinity control theory, together with an illustrative example of the effects of a gust on aircraft performance during landing.

O.C.

A91-54591

APPLYING DEVELOPMENT-MEMORY TECHNOLOGY TO AVIONICS SOFTWARE SUPPORT

MARC J. PITARYS (USAF, Wright Research and Development Center, Wright-Patterson AFB, OH) and RICHARD A. FALCIONI (Hughes Aircraft Co., Los Angeles, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 93-95. Copyright

The challenges facing avionics software support personnel are discussed, and the software support technology for advanced avionics systems that can cope with these challenges and complexities is addressed. The results of ongoing work being performed by the Wright Research and Development Center (WRDC) for the embedded computer resource support improvement program are detailed. The findings of the modular embedded computer software effort being conducted for WRDC's software concepts group are described. In a recent effort, a software development paradigm, based on automation, that addresses the knowledge gap faced by software support personnel has been identified. The underlying premise of this model is that software and its delivered documentation need to be united into an integrated system development product (ISDP), where relevant support information is organized into a structured hypermedia knowledge base. The key to this software design knowledge program is that the ISDP be integrated by means of a computerized development memory, which contains all of the motivation and rationale that influenced the development of the software. The development memory and its support software would serve a large-scale software development effort in the same way as human memory serves a single developer.

I.E.

A91-54592

AUTOMATIC PROGRAMMING TECHNOLOGIES FOR AVIONICS SOFTWARE (APTAS)

JAMES S. WILLIAMSON (USAF, Avionics Laboratory, Wright-Patterson AFB, OH), PAUL S. JENSEN, LORI OGATA, and W. H. GRAVES (Lockheed Research Laboratories, Palo Alto, CA)

IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 96-100. refs

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The APTAS software development environment, which provides automatic programming support for both rapid prototyping and target software system development in Ada, is described. APTAS utilizes domain-specific knowledge base support for automatic code synthesis from high-level system specifications. Each domain knowledge base includes both generic system architectures, in the form of templates, and design rules which capture carefully developed implementation strategies of various high-level specifications. Early users of this system will be systems and software engineers whose responsibility is to develop avionics system architectures. With the APTAS system, engineers will be able to quickly compare and contrast various architectural designs, including hardware and software tradeoffs, by testing instrumented, operational prototypes. The engineer will specify the system in a high-level specification language tailored to the functional area. Drawing from a knowledge base germane to the specification, APTAS will then interpret the specification in order to synthesize executable code. The high-level design language CIDL is a key element of APTAS, since it provides all the resources required to specify and test real-time, parallel processing systems needed for avionics applications. I.E.

A91-54594

AUTOMATING TEST DRIVER GENERATION

GARY L. DEHLIN (Honeywell, Inc., Sperry Commercial Flight Systems Group, Phoenix, AZ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 107-110.

Copyright

The present Test Generation System (TGS), which assists test engineers in the production of test drivers by consolidating source code and test case information in a common database from which a complete test driver is created, is described. Automating test driver production reduces labor investment, while standardizing the test driver development process and its products. TGS improves test engineer productivity by identifying the inputs and outputs of the routines under test, providing a user-friendly interface for defining tests, and generating test drivers. TGS has recently been released to two major project groups. The extent of the productivity gains which TGS has provided to the testing effort for these groups has yet to be determined, though the outlook is promising. I.E.

A91-54598

FAULT TOLERANT MODULAR DISTRIBUTED ARCHITECTURE FOR A HYPERSONIC VEHICLE MANAGEMENT SYSTEM

WAYNE E. GRIESEL (Unisys Corp., Saint Paul, MN) and ASHWANI K. CHAUDHARY (Rockwell International Corp., Downey, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 141-146.

Copyright

An approach for implementing a distributed processing architecture as the vehicle management control element for future hypersonic vehicle applications is described. Key features of the architecture which provide fault tolerance include redundancy management, processor synchronization, and multiple voting planes. Modular building blocks for constructing such a distributed vehicle management data processing system, based on contemporary common module designs, are described along with resulting performance attributes. The application of software support environments, including Ada, is presented. An assessment of resulting reliability and safety is also presented. It is concluded that the use of standardized building blocks provides a flexible, cost-effective method for designing, assembling, validating, producing, and operating a variety of application-specific

implementations. The same flexible features allow for future growth to include additional system capabilities with a minimum impact on already fielded configurations. I.E.

A91-54600

ARTIFICIAL INTELLIGENCE PROGRAMMING IN ADA

KENNETH R. LEEPER (Boeing Military Airplanes, Seattle, WA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 159-164. refs

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The Boeing Advanced Blackboard Ada Generation Environment (BABBAGE), a development environment with an associated toolset intended for specific blackboard paradigm, is presented. BABBAGE will provide a means of rapidly defining, implementing, debugging, maintaining, and documenting an artificial intelligence program in Ada. Topics discussed are the intended functionality of the environment, the relationship of the environment to the Ada language, and the current development status. I.E.

A91-54611* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

FAULT RECOVERY CHARACTERISTICS OF THE FAULT TOLERANT MULTI-PROCESSOR

PETER A. PADILLA (NASA, Langley Research Center, Hampton, VA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 248-253. refs

The fault handling performance of the fault tolerant multiprocessor (FTMP) was investigated. Fault handling errors detected during fault injection experiments were characterized. In these fault injection experiments, the FTMP disabled a working unit instead of the faulted unit once every 500 faults, on the average. System design weaknesses allow active faults to exercise a part of the fault management software that handles byzantine or lying faults. It is pointed out that these weak areas in the FTMP's design increase the probability that, for any hardware fault, a good LRU (line replaceable unit) is mistakenly disabled by the fault management software. It is concluded that fault injection can help detect and analyze the behavior of a system in the ultra-reliable regime. Although fault injection testing cannot be exhaustive, it has been demonstrated that it provides a unique capability to unmask problems and to characterize the behavior of a fault-tolerant system. I.E.

A91-54613

AVIONICS OPERATIONAL FLIGHT PROGRAM SOFTWARE SUPPORTABILITY

DONNA MORRIS (USAF, Avionics Laboratory, Wright-Patterson AFB, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 265-267.

It is noted that distributed and highly integrated software now in design/development, as well as parallel processing and artificial intelligence concepts, put additional strains on the testability, instrumentation of software, dynamic support environment, and validation capabilities. The work being done under the embedded computer resources support improvement program to meet these challenges by addressing the development of an advanced low-cost software support capability and developing a rapid turnaround capability for software is described. A modular, reconfigurable support environment has been demonstrated for the F-16, which incorporates off-the-shelf components where applicable, Ada simulation modules, nonintrusive dynamic debug, and real-time networks. Techniques to accomplish a rapid turnaround of software in response to mission or threat changes are discussed. I.E.

A91-54614

LABORATORY CONCEPTS IN AVIONICS SOFTWARE

ROBERT L. HARRIS (USAF, Avionics Laboratory, Wright-Patterson

15 MATHEMATICAL AND COMPUTER SCIENCES

AFB, OH) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 268-271. refs

Several concepts which are the focus of software technology at the USAF Avionics Laboratory are discussed: (1) automatic programming, (2) software fault tolerance, (3) reusable software, (4) expert code modification, (5) common Ada run-time systems, and (6) modular embedded software for distributed systems. These concepts apply to three phases of avionics systems life: conceptual, developmental, and operational. It is noted that breakthroughs in any one of these concepts will result in an order-of-magnitude improvement in the operations, performance, and maintenance of avionics in tactical weapon systems. I.E.

A91-54615

INTEGRATED TOOLSET FOR HIGH-INTEGRITY SYSTEM VERIFICATION AND VALIDATION SUPPORT

RALF P. CABOS (VDO Luftfahrtgeraete Werk Adolf Schindling GmbH, Frankfurt am Main; Berlin, Technische Universitaet, Federal Republic of Germany) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 272-277. refs

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The basic principles and underlying design of a toolset for high-integrity system verification and validation support are presented. First experiences in the application of the toolset to an avionics software maintenance project are discussed. An outline is given of current work, which features the extension of the existing toolset to a certification support system. I.E.

A91-54616* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

APPLICATION OF INDUSTRY-STANDARD GUIDELINES FOR THE VALIDATION OF AVIONICS SOFTWARE

KELLY J. HAYHURST (NASA, Langley Research Center, Hampton, VA) and ANITA M. SHAGNEA (Research Triangle Institute, Research Triangle Park, NC) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 278-282. Research supported by FAA. refs

(Contract NAS1-17964)

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The application of industry standards to the development of avionics software is discussed, focusing on verification and validation activities. It is pointed out that the procedures that guide the avionics software development and testing process are under increased scrutiny. The DO-178A guidelines, Software Considerations in Airborne Systems and Equipment Certification, are used by the FAA for certifying avionics software. To investigate the effectiveness of the DO-178A guidelines for improving the quality of avionics software, guidance and control software (GCS) is being developed according to the DO-178A development method. It is noted that, due to the extent of the data collection and configuration management procedures, any phase in the life cycle of a GCS implementation can be reconstructed. Hence, a fundamental development and testing platform has been established that is suitable for investigating the adequacy of various software development processes. In particular, the overall effectiveness and efficiency of the development method recommended by the DO-178A guidelines are being closely examined. I.E.

A91-54617

A SOFTWARE-FIRST METHODOLOGY FOR DEFINITION AND EVALUATION OF ADVANCED AVIONICS ARCHITECTURES

S. RAHMANI (Rockwell International Corp., Space Systems Div., Downey, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc.,

1990, p. 283-288. refs

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Since software has become the major cost driver among the avionics subsystems, a methodology has been developed for definition of advanced avionics architectures with special emphasis on software. It utilizes explicit software contributing factors for avionics architecture design and assessment. The methodology is based on a four-step process: (1) definition of candidate data management systems (DMSs), (2) definition of candidate avionics architectures, (3) architecture evaluation from software and other subsystem viewpoints, and (4) architecture evaluation from total avionics system viewpoint. User-defined software contributing factors, along with those for other subsystems, are used to define and evaluate the architectures objectively. The methodology was applied to a generic avionics system, resulting in a set of candidate avionics architectures and associated evaluation data. I.E.

A91-54632

AUTOMATED FAULT TOLERANCE EVALUATOR FOR SYSTEM DESIGN, SIMULATION, AND ANALYSIS

LAURA L. PULLUM (SRS Technologies, Huntsville, AL) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 360-365. refs

Copyright

An automated fault tolerance design, simulation, and analysis tool is described which enables users to evaluate reliability and fault tolerant characteristics of complex and adaptive multiprocessing systems. The evaluation tool employs graphics and text user interfaces, redesigned software and hardware fault tolerance templates, graphics model preprocessing and simulation, and analysis and postprocessing techniques to provide offline reliability and fault tolerance measures for proposed software and/or hardware systems. The automated fault tolerance evaluator (AFTE) tool set allows system designers and analysts to implement fault tolerance early in the design phase through a validated computer-aided engineering environment. If fault tolerance capability must be added to existing systems, AFTE provides rapid modeling and analysis capability to support retrofit design efforts. The library of widely used components and fault tolerance templates aids the rapid development of simulation models of design alternatives and easy incorporation of validated fault tolerance process models into the system model. The simulation and analysis capabilities enable the user to validate system designs, evaluate alternative designs, and point out areas of possible redesign. I.E.

A91-54634* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

FAULT-TOLERANT PARALLEL PROCESSORS FOR AVIONICS WITH REDUCED MAINTENANCE

DAVID A. RENNELS and JOHN A. ROHR (JPL, Pasadena, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 372-377. refs

Copyright

Architectural issues and approaches for implementing fault-tolerant parallel processors in avionics systems and other dedicated applications requiring high levels of dependability are discussed. For these systems it is desirable to provide both a high degree of fault tolerance and a system that can operate for extended periods of time without external maintenance. With current technology it is possible to operate dependably for months between maintenance events. The longer-term goal should be maintenance-free operation (a computer that outlasts its host system). It is argued that new high-density packaging techniques may make this type of long-life fault-tolerant design an attractive choice in controlling the life-cycle costs of the next generation of systems. I.E.

A91-54654

TAILORING CONFIGURATION MANAGEMENT TOOLS FOR DEVELOPMENT OF AVIONICS SOFTWARE

JOHN UCZEKAJ and BANNI HUGHES (Honeywell, Inc., Commercial Flight Systems Group, Phoenix, AZ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 493-498.

Copyright

The automated configuration management system (ACM), a library system for software development and maintenance on VAX/VMS systems, is described. ACM maintains its library of information through the basic file management services of VMS and through two purchased DEC tools: a relational database (DEC Rdb/VMS) and a code management system (DEC/CMS). ACM stores, controls access to, and tracks changes to project files in order to coordinate software development and maintenance activities for large projects. The automated documentation system is considered, and future extensions to ACM are discussed. The use of ACM is then examined, with attention given to traceability testing and change tracking. I.E.

A91-54658* Bolt, Beranek, and Newman, Inc., Cambridge, MA.
SITUATIONAL AWARENESS IN THE COMMERCIAL AIRCRAFT COCKPIT - A COGNITIVE PERSPECTIVE

MARILYN J. ADAMS and RICHARD W. PEW (Bolt Beranek and Newman, Inc., Cambridge, MA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 519-524. refs
 (Contract NAS1-18788)

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A cognitive theory is presented that has relevance for the definition and assessment of situational awareness in the cockpit. The theory asserts that maintenance of situation awareness is a constructive process that demands mental resources in competition with ongoing task performance. Implications of this perspective for assessing and improving situational awareness are discussed. It is concluded that the goal of inserting advanced technology into any system is that it results in an increase in the effectiveness, timeliness, and safety with which the system's activities can be accomplished. The inherent difficulties of the multitask situation are very often compounded by the introduction of automation. To maximize situational awareness, the dynamics and capabilities of such technologies must be designed with thorough respect for the dynamics and capabilities of human information-processing. I.E.

A91-54675

FAULT TOLERANT FIBER OPTIC FLIGHT CONTROL SYSTEM

BILL SCHWABENLAND, JOHN STIPANOVICH, BRIAN SMITH, KEVIN THOMPSON, and MAHESH REDDY (Boeing Aerospace and Electronics, Seattle, WA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 638-644.

Copyright

A fault-tolerant flight control architecture using optical transducers and transmission lines to produce a system which is relatively unaffected by electromagnetic interference and which provides significant weight savings is discussed. Emphasis is placed on two architectures of an optical flight control system designed for use in a redundant flight control system. Option one is a passive system which requires no power transmission lines to the optical components at the actuator. All of the optical signals are returned to the optical interface electronics in the flight control computer and are processed in the box. Option two is an active system in which optical data are sent from the flight control computer to the actuator along an optical bus, usually a MIL-STD-1773 1-to-2 Mb bus, and then back to the flight control computer along the same bus. In option two, the closed-loop control around the actuator is done with a microprocessor in the actuator control

electronics module (ACE), which is an electronic box placed on the actuator and powered by a 28-V line from the flight control computer power supply. This concept is considered active because 28-V power is transmitted outside the flight control computer. It is shown how active systems could be used to provide feedback to the flight control processor and how each system interfaces to the flight control computer. I.E.

A91-54680

NEURAL NETWORKS AND DIGITAL AVIONICS

ABRAHAM N. SEIDMAN (Northrop Corp., Aircraft Systems Div., Hawthorne, CA) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 669-678. refs

Copyright

The application of neural networks is considered as a method of solution to a number of outstanding problems in aircraft avionics. The areas of application of artificial neural networks to avionics dealt with are: (1) target selection, (2) attack planning/steering, and (3) track-before-detect. The target selection is approached by the application of a feedforward, backpropagation network. The attack planning/steering is approached by a novel type of parallel processing neural network. The track-before-detect is solved via a feedforward backpropagation network. The feedforward backpropagation algorithms can be implemented on fast systolic-array-type neural chips. A special, fast path generation chip can be developed. Consequently, a low-cost, high-speed, compact solution to a number of avionics functions is available through neural networks. I.E.

A91-54681

DYNAMIC MODEL DEPENDENCY FOR A DECENTRALIZED LINEAR-QUADRATIC-GAUSSIAN CONTROL PROBLEM

K. MALAKIAN and A. VIDMAR (GE Aerospace, Moorestown, NJ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 680-696. refs

Copyright

A decentralized control problem is considered with sensors, controls, and local Kalman estimators at each node for independence and redundancy. Controls, using the best estimate of the system state, are sought to minimize a quadratic performance index. It is noted that cross-correlation between the nodal estimates due to process noise in the dynamics model must be considered for proper fusion of the estimates. The authors demonstrate the underestimation of the control error variance from neglecting estimate cross correlation via the rendezvous problem for the linear quadratic (LQ) regulator or the flight path control problem for the LQ tracker dynamic models. When steady-state Kalman filters can be used, the calculation and information requirements are significantly reduced. The underestimation of the control error variance is shown to be nonnegligible at high gain values for these filters for each of the dynamics models considered in the rendezvous problem. I.E.

A91-56099* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE NAS PARALLEL BENCHMARKS

D. H. BAILEY, E. BARSZCZ, J. T. BARTON, R. L. CARTER, T. A. LASINSKI (NASA, Ames Research Center, Moffett Field, CA), D. S. BROWNING, L. DAGUM, R. A. FATOOHI (NASA, Ames Research Center; Computer Sciences Corp., Moffett Field, CA), P. O. FREDERICKSON, R. S. SCHREIBER (NASA, Ames Research Center; Research Institute for Advanced Computer Science, Moffett Field, CA) et al. International Journal of Supercomputer Applications (ISSN 0890-2720), vol. 5, Fall 1991, p. 63-73. refs
 (Contract NAS2-12961; NCC2-387)

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A new set of benchmarks has been developed for the performance evaluation of highly parallel supercomputers in the framework of the NASA Ames Numerical Aerodynamic Simulation

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(NAS) Program. These consist of five 'parallel kernel' benchmarks and three 'simulated application' benchmarks. Together they mimic the computation and data movement characteristics of large-scale computational fluid dynamics applications. The principal distinguishing feature of these benchmarks is their 'pencil and paper' specification-all details of these benchmarks are specified only algorithmically. In this way many of the difficulties associated with conventional benchmarking approaches on highly parallel systems are avoided. Author

A91-56129* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ENHANCING AEROPROPULSION RESEARCH WITH HIGH-SPEED INTERACTIVE COMPUTING

JOHN R. SZUCH, DALE J. ARPASI, and ANTHONY J. STRAZISAR (NASA, Lewis Research Center, Cleveland, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 286-298. Previously announced in STAR as N91-24796. refs Copyright

NASA-Lewis has committed to a long range goal of creating a numerical test cell for aeropropulsion research and development. Efforts are underway to develop a first generation Numerical Propulsion System Simulation (NPSS). The NPSS will provide a unique capability to numerically simulate advanced propulsion systems from nose to tail. Two essential ingredients to the NPSS are: (1) experimentally validated Computational Fluid Dynamics (CFD) codes; and (2) high performing computing systems (hardware and software) that will permit those codes to be used efficiently. To this end, NASA-Lewis is using high speed, interactive computing as a means for achieving Integrated CFD and Experiments (ICE). The development is described of a prototype ICE system for multistage compressor flow physics research. Author

N91-31814# Computer Resource Management, Inc., Pleasantville, NJ.

SOFTWARE QUALITY METRICS Final Report

N. VANSUETENDAEL and D. ELWELL Jul. 1991 267 p (Contract DTFA03-86-C-00042) (DOT/FAA/CT-91/1) Avail: NTIS HC/MF A12

When digital technology is employed to perform some function aboard aircraft, the designer documents the technology and the applicant presents a package to the Certification Engineer (CE). Typically, the package might include design and test specifications, test plans, and test results for the system. This package assures the CE that the designer has properly developed and validated the system. Software Quality Metrics (SQM) may be used during the software (SW) development and testing. The SQM technology attempts to quantify various quality-oriented factors, such as reliability and maintainability. The SW developer determines the quality factors that are important to the application. The SW metrics that correlate to these factors are used on the code to determine to what extent these factors were reached. Based on the results, the developer determines whether the SW meets the requirements set for it and how well the SW will perform. This technical report documents the results of a study conducted to analyze SQM as they apply to the code contained in avionics equipment and systems. This report is intended to provide an indepth explanation of how SQM may be applied and interpreted. Author

N91-31848# Association Aeronautique et Astronautique de France, Paris.

POST PROCESSING OF THREE DIMENSIONAL AEROTHERMAL COMPUTATION [POST-TRAITEMENT DE CALCUL AEROTHERMIQUES TRIDIMENSIONNELS]

A. LUC-BOUHALI, D. DEVEZEAXDELAVERGNE, V. KURG, and Y. LECOINTE (Ecole Nationale Supérieure de Mécanique, Nantes, France) 1989 13 p In FRENCH Presented at the 26th Colloque d'Aérodynamique Appliquée, Toulouse, France, 23-25 Oct. 1990 Previously announced in IAA as A90-21050 (AAAF-NT-89-21; ISBN-2-7170-0954-X; ISSN-0243-0177;

ETN-91-99962) Avail: NTIS HC/MF A03; CEDOCAR, Section des Diffusions, 26 Blvd Victor, 75996 Paris Armees, France, HC 15 francs

Graphics software programs which visualize static and dynamic 3-D aerodynamic computation results are described. The BLUNT code, which solves 3-D unsteady Euler equations, and the STEIN super/hypersonic Euler code are discussed. Post processing of 3-D results and visualization of 3-D surfaces are discussed. The ASCETE (French acronym for aid to simulation and comprehension of 3-D external flows) and its two derivatives, COUPE3D and ANIM3D are discussed. ESA

N91-31874*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

A KNOWLEDGE BASED APPLICATION OF THE EXTENDED AIRCRAFT INTERROGATION AND DISPLAY SYSTEM

RICHARD D. GLOVER and RICHARD R. LARSON Washington Oct. 1991 39 p (NASA-TM-4327; H-1706; NAS 1.15:4327) Avail: NTIS HC/MF A03 CSCL 09/2

A family of multiple-processor ground support test equipment was used to test digital flight-control systems on high-performance research aircraft. A unit recently built for the F-18 high alpha research vehicle project is the latest model in a series called the extended aircraft interrogation and display system. The primary feature emphasized monitors the aircraft MIL-STD-1553B data buses and provides real-time engineering units displays of flight-control parameters. A customized software package was developed to provide real-time data interpretation based on rules embodied in a highly structured knowledge database. The configuration of this extended aircraft interrogation and display system is briefly described, and the evolution of the rule based package and its application to failure modes and effects testing on the F-18 high alpha research vehicle is discussed. Author

N91-32850*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.

A NASA/RAE COOPERATION IN THE DEVELOPMENT OF A REAL-TIME KNOWLEDGE-BASED AUTOPILOT

COLIN DAYSH, MALCOLM CORBIN, GEOFF BUTLER, EUGENE L. DUKE, STEVEN D. BELLE, and RANDAL W. BRUMBAUGH (PRC Kentron, Inc., Edwards, CA.) Aug. 1991 15 p Presented at the Avionics Panel Symposium, Lisbon, Portugal, May 1991 (NASA-TM-104234; H-1727; NAS 1.15:104234) Avail: NTIS HC/MF A03 CSCL 09/2

As part of a US/UK cooperative aeronautical research program, a joint activity between the NASA Dryden Flight Research Facility and the Royal Aerospace Establishment on knowledge-based systems was established. This joint activity is concerned with tools and techniques for the implementation and validation of real-time knowledge-based systems. The proposed next stage of this research is described, in which some of the problems of implementing and validating a knowledge-based autopilot for a generic high-performance aircraft are investigated. Author

N91-32853*# California Univ., Davis.

THE FORMAL VERIFICATION OF GENERIC INTERPRETERS Final Report

P. WINDLEY, K. LEVITT, and G. C. COHEN (Boeing Military Airplane Development, Seattle, WA.) Washington NASA Oct. 1991 203 p (Contract NAS1-18586) (NASA-CR-4403; NAS 1.26:4403) Avail: NTIS HC/MF A10 CSCL 09/2

The task assignment 3 of the design and validation of digital flight control systems suitable for fly-by-wire applications is studied. Task 3 is associated with formal verification of embedded systems. In particular, results are presented that provide a methodological approach to microprocessor verification. A hierarchical decomposition strategy for specifying microprocessors is also presented. A theory of generic interpreters is presented that can be used to model microprocessor behavior. The generic interpreter

theory abstracts away the details of instruction functionality, leaving a general model of what an interpreter does. Author

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A91-53812#**JET NOISE REDUCTION CONCEPTS FOR THE SUPERSONIC TRANSPORT**

G. A. CHAMPAGNE (United Technologies Corp., Pratt and Whitney Group, West Palm Beach, FL) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 955-961. (AIAA PAPER 91-3328) Copyright

Two concepts are examined in order to comply with FAR Stage 3 noise standards in the design of propulsion systems for high-speed civil transports. The first concept uses an inlet flow valve and mixer ejector nozzle that bring in 74 percent more airflow into the engine's inlet and 46 percent into the engine's exhaust nozzle. The second utilizes a mixer ejector nozzle to increase the engine's exhaust flow by 120 percent. The impacts of these concepts on engine design, size, weight, performance, and on TOGW and range are examined. R.E.P.

A91-53826* Florida Atlantic Univ., Boca Raton.**PREDICTION OF BLADE WAKE INTERACTION NOISE BASED ON A TURBULENT VORTEX MODEL**

STEWART A. L. GLEGG (Florida Atlantic University, Boca Raton) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1545-1551. Previously cited in issue 13, p. 2051, Accession no. A89-33764. refs (Contract NAG1-715) Copyright

A91-53828* Minnesota Univ., Minneapolis.**STUDY OF THE NOISE MECHANISMS OF TRANSONIC BLADE-VORTEX INTERACTIONS**

A. S. LYRINTZIS (Minnesota, University, Minneapolis) and Y. XUE AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1562-1572. Research supported by University of Minnesota. Previously cited in issue 05, p. 748, Accession no. A91-17642. refs (Contract NAG2-588; NAG2-646) Copyright

A91-53847**IMPROVED MODE-SUPERPOSITION TECHNIQUE FOR MODAL FREQUENCY RESPONSE ANALYSIS OF COUPLED ACOUSTIC-STRUCTURAL SYSTEMS**

ZHENG-DONG MA (Jilin University of Technology, Changchung, People's Republic of China) and ICHIRO HAGIWARA (Nissan Motor Co., Ltd., Yokosuka, Japan) AIAA Journal (ISSN 0001-1452), vol. 29, Oct. 1991, p. 1720-1726. refs Copyright

The modal frequency response (MFR) of a coupled acoustic-structural system is presently obtained via a novel formulation employing a coupled-system orthogonality condition. A compensation technique is proposed for the effects of lower and/or higher modes that lie beyond the frequency domain of an MFR analysis. The application of this technique significantly improves convergence, and makes possible the determination of frequency response with accuracies superior to those of the mode-displacement method and the mode-acceleration method, without increasing computational effort. O.C.

A91-53882#**AN EFFICIENT METHOD FOR INCORPORATING COMPUTATIONAL FLUID DYNAMICS INTO SONIC BOOM PREDICTION**

JULIET A. PAGE (Douglas Aircraft Co., Long Beach, CA) and KENNETH J. PLOTKIN (Wyle Laboratories, Arlington, VA) AIAA, Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991. 17 p. refs (AIAA PAPER 91-3275) Copyright

A method has been developed for utilizing Computational Fluid Dynamics (CFD) flow solutions as a starting point for sonic boom propagation calculations. An existing CFD code was shown to predict near-field flow with adequate resolution for sonic boom analysis. However, within the flowfield domain for which this CFD calculation is practical, there can be significant unresolved diffraction effects. Neglecting these effects can underpredict boom at the ground. A matching methodology has therefore been developed, based on an acoustic multipole formulation. The multipole formulation allows a transformation from near-field flow to the final far-field azimuthal pattern. An example of the application of this methodology to a wing-body configuration is presented. Author

A91-54618**ASSESSMENT OF PHOTONICS FOR ADVANCED INTEGRATED AVIONICS PROCESSORS - PAVE PACE**

CHRISTOPHER L. ALLYN, EDWARD M. HUMMEL, and RICHARD J. PIMPINELLA (AT&T Bell Laboratories, Whippany, NJ) IN: IEEE/AIAA/NASA Digital Avionics Systems Conference, 9th, Virginia Beach, VA, Oct. 15-18, 1990, Proceedings. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 289-292. refs Copyright

It is suggested that advanced photonics offers major benefits to next-generation military avionics in terms of performance, reliability, and cost-effectiveness. The trends in photonic technologies are discussed, and their applicability for use in integrated avionics systems is assessed. Optical switching, interconnection, and processing are discussed, as well as the potential benefits to advanced architectures such as PAVE PACE. It is concluded that the movement and management of large amounts of data in upcoming systems will not be possible without optics. The major impact will be the widespread use of fiber transmission and optical switching. It is expected that advanced photonic technology for sensors and system networking (e.g., fly-by-light and smart structures and skins) will also support important improvements in platform performance. I.E.

A91-55693**THE '90'S - DECADE OF QUIETER ROTORCRAFT: AN IDEA WHOSE TIME IS NECESSARY**

HARRY STERNFELD, JR. Vertiflite (ISSN 0042-4455), vol. 37, Sept.-Oct. 1991, p. 40-44. refs Copyright

A review is presented of the problems, research and design concepts for alleviating rotorcraft noise and meeting the civil aeronautics noise standards. The military has also been expressing concern for helicopter noise both as it affects the civilian population and, in some cases, detection by both human and electronic arrays. Attention is given to the impact on design, the principal sources of helicopter rotor noise, the effect of duct design on fan noise fundamental, and interface with the infrastructure. R.E.P.

A91-56987**INSTITUTE OF NAVIGATION, ANNUAL MEETING, 46TH, ATLANTIC CITY, NJ, JUNE 26-28, 1990, PROCEEDINGS**

Conference supported by Institute of Navigation, Canadian Marconi Co., Delco Electronics Corp., et al. Washington, DC, Institute of Navigation, 1990, 229 p. For individual items see A91-56988 to A91-57000.

Topics presented include test results of GPS integration with Carrier Aircraft Inertial Navigation System, the Decimeter Positioning System, safety implications of automobile navigation

systems, and precision electronic navigation in restricted waterways. Also presented are marine inertial navigation into the 21st century, some environmental effects on the differential GPS, the effect of geometry on integrity monitoring performance, and production development of small fiber optic gyros. R.E.P.

N91-31923*# Lockheed Engineering and Sciences Co., Hampton, VA.

USER'S MANUAL FOR THE LANGLEY BOUNDARY LAYER NOISE PROPAGATION PROGRAM (MRS-BLP)

PETER L. SPENCE Aug. 1991 38 p

(Contract NAS1-19000)

(NASA-CR-187559; NAS 1.26:187559) Avail: NTIS HC/MF A03 CSDL 20/1

A computer program, McAninch-Rawls-Spence Boundary Layer Propagation (MRS-BLP), is described. This program models the refractive and scattering effects on acoustic pressure waves propagating through a boundary layer encompassing an aircraft's fuselage. The noise source is assumed known and generated by a propeller. The fuselage is represented by an infinitely long cylinder embedded in a longitudinal flow. By matching a numerical solution inside the boundary layer with an analytical solution outside the boundary layer, the program calculates the acoustic pressure at the surface of the cylinder given the incident field at the top of the boundary layer. The boundary layer flow velocity and sound speed profiles, as well as the boundary layer thickness may be specified by the user. A detailed description of the input parameters and how to execute the program is given. Example executions of MRS-BLP showing results are also included. Author

N91-31926*# Douglas Aircraft Co., Inc., Long Beach, CA.

FUSELAGE SHELL AND CAVITY RESPONSE

MEASUREMENTS ON A DC-9 TEST SECTION Final Report

M. A. SIMPSON, G. P. MATHUR, M. R. CANNON, B. N. TRAN, and P. L. BURGE Aug. 1991 55 p

(Contract NAS1-18037)

(NASA-CR-187557; NAS 1.26:187557) Avail: NTIS HC/MF A04 CSDL 20/1

A series of fuselage shell and cavity response measurements conducted on a DC-9 aircraft test section are described. The objectives of these measurements were to define the shell and cavity model characteristics of the fuselage, understand the structural-acoustic coupling characteristics of the fuselage, and measure the response of the fuselage to different types of acoustic and vibration excitation. The fuselage was excited with several combinations of acoustic and mechanical sources using interior and exterior loudspeakers and shakers, and the response to these inputs was measured with arrays of microphones and accelerometers. The data were analyzed to generate spatial plots of the shell acceleration and cabin acoustic pressure field, and corresponding acceleration and pressure wavenumber maps. Analysis and interpretation of the spatial plots and wavenumber maps provided the required information on modal characteristics, structural-acoustic coupling, and fuselage response. Author

N91-31927*# Douglas Aircraft Co., Inc., Long Beach, CA.

ANALYSIS OF INTERIOR NOISE GROUND AND FLIGHT TEST DATA FOR ADVANCED TURBOPROP AIRCRAFT APPLICATIONS Final Report

M. A. SIMPSON and B. N. TRAN Aug. 1991 66 p

(Contract NAS1-18037)

(NASA-CR-187558; NAS 1.26:187558) Avail: NTIS HC/MF A04 CSDL 20/1

Interior noise ground tests conducted on a DC-9 aircraft test section are described. The objectives were to study ground test and analysis techniques for evaluating the effectiveness of interior noise control treatments for advanced turboprop aircraft, and to study the sensitivity of the ground test results to changes in various test conditions. Noise and vibration measurements were conducted under simulated advanced turboprop excitation, for two interior noise control treatment configurations. These ground measurement results were compared with results of earlier UHB (Ultra High Bypass) Demonstrator flight tests with comparable interior

treatment configurations. The Demonstrator is an MD-80 test aircraft with the left JT8D engine replaced with a prototype UHB advanced turboprop engine. Author

N91-31928*# Minnesota Univ., Minneapolis. Dept. of Aerospace Engineering and Mechanics.

A PARAMETRIC STUDY OF TRANSONIC BLADE-VORTEX INTERACTION NOISE Final Technical Report, 1 Jul. 1990 - 30 Jun. 1991

A. S. LYRINTZIS 30 Jun. 1991 59 p

(Contract NAG6-626)

(NASA-CR-188811; NAS 1.26:188811) Avail: NTIS HC/MF A04 CSDL 20/1

Several parameters of transonic blade-vortex interactions (BVI) are being studied and some ideas for noise reduction are introduced and tested using numerical simulation. The model used is the two-dimensional high frequency transonic small disturbance equation with regions of distributed vorticity (VTRAN2 code). The far-field noise signals are obtained by using the Kirchhoff method with extends the numerical 2-D near-field aerodynamic results to the linear acoustic 3-D far-field. The BVI noise mechanisms are explained and the effects of vortex type and strength, and angle of attack are studied. Particularly, airfoil shape modifications which lead to noise reduction are investigated. The results presented are expected to be helpful for better understanding of the nature of the BVI noise and better blade design. Author

N91-31946 Grumman Aerospace Corp., Bethpage, NY.

AVIOPTIC PLUG-IN INTERCONNECTION Patent

ANTHONY L. CASERTA, inventor and BRUNO LIJOI, inventor 23 May 1989 15 p

(PATENT-1-254-415; INT-PATENT-CLASS-G02B-6z4;

CTN-91-60172) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada HC \$4.00 CAN, MF \$2.75 CAN

A secure interconnection is claimed for optical and avioptic cables located in exposed positions, which often occur on aircraft communications circuits, for connecting those cables into equipment such as circuit boards. In this invention the interconnection for optical fiber cables comprises a connector which is engaged in a receptacle in a mother board provided with optical circuitry. The connector comprises a cuplike body or plug containing a metal sleeve which encases the optical fiber cable such that the cable end is exposed. The mating receptacle comprises a cylindrical shell having its lower end embedded in the mother board. A hole in the receptacle shell wall receives the end of an optical fiber on the optical circuitry of the mother board. The end of the sleeve of the connector fits over the end of the receptacle shell protruding from the mother board. Beam deflection means in the receptacle or on the connector directs light between the fiber optic cable and the optical circuit element of the mother board. Electrical coupling can be incorporated into the interconnection such that the termination can accommodate electrical as well as optical functions. CISTI

N91-32873 National Physical Lab., Teddington (England). Div. of Radiation Science and Acoustics.

NOISE LEVELS OF USAF AIRCRAFT IN EXERCISE LUCE BELLE

B. F. BERRY, R. C. PAYNE, and A. L. HARRIS Feb. 1991 25 p Sponsored by Ministry of Defence

(NPL-RSA(EXT)-16; ISSN-0955-9655; ETN-91-99869) Copyright Avail: National Physical Lab., Teddington, Middlesex TW11 0LW, England

AIRNOISE, a mathematical model for computing aircraft noise contours is extended to include low altitude military operations. The objective is to predict not only maximum levels but also the onset rate of the noise of these very rapid events. To provide data with which to validate and refine the prediction model a trial was conducted (exercise Luce Belle) in which a number of different aircraft types were flown straight and level at heights between about 100 and 400 feet, at various speeds and engine power

settings. The trial is reported and the results obtained for two USAF (U.S. Air Force) aircraft, an F-15 and an F-16, are presented. ESA

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A91-53044

LESSONS LEARNED DEVELOPING ORGANIC SUPPORT FOR AVIONICS EQUIPMENT

CHARLES GELFOND, RALPH JOHNS, and DAVID PRESTO (ITT Corp., ITT Avionics Div., Nutley, NJ) IN: AUTOTESTCON '90; IEEE Systems Readiness Technology Conference, San Antonio, TX, Sept. 17-20, 1990, Conference Record. New York, Institute of Electrical and Electronics Engineers, Inc., 1990, p. 435-439. Copyright

The authors summarize some elements of the test program set (TPS) total quality management (TQM) challenge encountered in providing full organic support to the government for an avionics system. The major issues discussed include vertical testability, automatic test equipment (ATE) immaturity, and TPS maturation. The problems encountered, subsequent actions, and lessons learned are addressed. It is concluded that a TQM approach must be employed for the design implementation and development of a successful TPS throughout the life cycle of the TPS. I.E.

A91-53240

AIAA TECHNICAL COMMITTEE ON MULTIDISCIPLINARY DESIGN OPTIMIZATION (MDO) - WHITE PAPER ON CURRENT STATE OF THE ART

Washington, DC, American Institute of Aeronautics and Astronautics, Jan. 15, 1991, 51 p. refs Copyright

Multidisciplinary design optimization (MDO) is reviewed in terms of the need for technological integration, recent advances in the mathematically based MDO systems and methodologies, and directions for research and development. The use of MDO in the aerospace industry is first considered historically, and the multidisciplinary character of the design process is emphasized. Design considerations related to human interface and computing are set forth to underscore the essential nature of these aspects. In addressing the issues of aerospace design, the MDO approach relies primarily on sensitivity analyses and optimization methods. A list of ten characteristics of the concurrent engineering process is given, and each item is addressed in terms of the corresponding MDO contribution. MDO is essentially an environment in which human, mathematics, and computer factors can be effectively combined to make sound design decisions. C.C.S.

A91-53585

USING PROTOTYPES AND FLIGHT VALIDATION IN TEACHING AEROSPACE SYSTEMS DESIGN

STEPHEN M. BATILL (Notre Dame, University, IN) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 14 p. Research supported by University of Notre Dame. refs (SAE PAPER 911176) Copyright

This paper details the approach taken in a course entitled 'Aerospace Systems Design' presented at the University of Notre Dame. It describes the course which is intended to introduce undergraduate students to the aircraft design process and to present them with a realistic design challenge. This course not only includes an introduction to techniques associated with conceptual design but requires the validation of the concept through fabrication and flight testing of a technology demonstrator. The

design course has focused on a special class of aircraft, unmanned flight vehicles or Remotely Piloted Vehicles. An overview of the organization of the course and the methods used to develop the designs are presented. Examples of design studies, prototype aircraft, and flight test results are also included. Author

A91-53588

DESIGN INTEGRATION DECISION MAKING - WHAT SHOULD BE TAUGHT?

JAN ROSKAM (Kansas, University, Lawrence) SAE, Aerospace Atlantic Conference, Dayton, OH, Apr. 22-26, 1991. 11 p. refs (SAE PAPER 911180) Copyright

Design integration is discussed to determine how significant the field is with respect to the elimination of design error, 'total engineering', and engineering education. Aircraft design is discussed, and some recent design mistakes are listed to identify the nature of the problems. Total engineering is defined as design engineering in which all areas of potential future problems are considered. The concept includes thorough failure checks, component accessibility and repairability, the establishment of acceptable costs and life-cycle costs, and the careful incorporation of design changes. The contribution of design education is considered, and it is determined that all aeronautical engineering students should be proficient in 9 crucial enabling technologies. C.C.S.

A91-53804#

THE USE OF MICROSOFT FLIGHT SIMULATOR IN AEROSPACE EDUCATION

E. J. JUMPER (Notre Dame, University, IN) and J. W. BAUGHN (California, University, Davis) IN: AIAA Applied Aerodynamics Conference, 9th, Baltimore, MD, Sept. 23-25, 1991, Technical Papers. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 875-883. refs (AIAA PAPER 91-3314) Copyright

The use of the PC-based computer program 'Microsoft Flight Simulator' in undergraduate aeronautical engineering education is described. At the University of Notre Dame, it is used in conjunction with an introductory course in aeronautics and provides a substitute for an actual flight test experience. At the University of California at Davis, it is used in conjunction with an aircraft flight performance laboratory course and augments actual flight test data taken in a Cessna 182. Author

A91-54036#

INTRODUCING DESIGN IN BASIC STRUCTURES COURSES

GERALD H. LINDSEY (U.S. Naval Postgraduate School, Monterey, CA) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 13 p. refs (AIAA PAPER 91-3113) Copyright

Subscribing to the premise that principles of design should be taught, along with analysis, throughout the engineering science courses, a series of example problems are presented that cover six of the ABET design activities. The design object begins as a uniform spar of rectangular cross-section, and it is kept simple throughout the entire series of design problems in order to keep the focus totally on developing design methods and tools. The material is presented in the format of a progression of increasingly more complex considerations in the design of a wing spar. It is intended for the beginning course in strength of materials and aircraft structures. Author

A91-54038#

AIRCRAFT DESIGN EDUCATION AT NCSU. II - A STUDENT'S PERSPECTIVE

JOHN N. PERKINS (North Carolina State University, Raleigh), JOHN AVENT, and NORMAN MERRITT AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 9 p. Research supported by Pratt and Whitney Group. (AIAA PAPER 91-3115) Copyright

The aerospace engineering education design program, from

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the perspective of two students at North Carolina State University, is described. The methods of analyses, construction, and flight testing are discussed. R.E.P.

A91-54039#

AN EXAMPLE OF INDUSTRIAL INTERACTION WITH AN UNDERGRADUATE AIRCRAFT DESIGN PROGRAM

STEVEN J. D'URSO (McDonnell Aircraft Co., Saint Louis, MO) and KENNETH R. SIVIER (Illinois, University, Champaign) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 19 p. refs (AIAA PAPER 91-3116) Copyright

The McDonnell Aircraft Company's interaction with the Aeronautical and Astronautical Engineering program at the University of Illinois is considered. Seven two-hour seminars in aircraft configuration design along with the introduction of a graduate-level aircraft design course are described, and focus is placed on processes, products, and tools as well as design drivers, aerodynamic considerations, and propulsion integration issues. Aircraft structures and systems are outlined, and careers in design are discussed. An experiment is described, in which Taguchi-parameter design techniques are applied to the fusion of several design parameters that make up aircraft specifications. With the goal of generating an aircraft with multimission capabilities, five designs are produced by the class, each with a different mission emphasis. V.T.

A91-54040#

TEACHING AIRCRAFT DESIGN AS AN UNDERGRADUATE CAPSTONE COURSE - A PERSPECTIVE

P. M. SAGDEO (Western Michigan University, Kalamazoo, MI) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 8 p. refs (AIAA PAPER 91-3117) Copyright

The integration of aircraft design and aircraft engineering into a design course for conceptual aircraft design is discussed. The B.S. degree in aircraft engineering relevant to the author's experience is described, and the integration of design is addressed with detailed descriptions of courses such as those regarding aircraft stability and control, structural design, and engine design. The course in aircraft conceptual design is then described, and the performance of students that take the class is assessed. Problems are noted such as loss of visualization ability, lack of retained knowledge in basic mathematics, and the inability to place retained knowledge into its proper context. Some basic recommendations are outlined for teaching synthesis in design classes, because analytical skills precede the ability to design. C.C.S.

A91-54749

FLIGHT SAFETY IN REUNIFIED GERMANY - ORGANIZATION AND UPGRADING OF FLIGHT SAFETY (FLUGSICHERUNG IM WIEDERVEREINIGTEN DEUTSCHLAND - ORGANISATION UND AUFBAU DER FLUGSICHERUNG)

TILMAN BOHR (Bundesanstalt fuer Flugsicherung, Frankfurt am Main, Federal Republic of Germany) Ortung und Navigation (ISSN 0474-7550), no. 2, 1991, p. 238-243. In German.

The air safety systems of the DDR are reviewed, and the need to update them in reunified Germany is examined. Near-term steps that need to be taken to upgrade air safety around Berlin are addressed. C.D.

A91-55458

A SMALL AIRSHIP IS ECONOMICAL FOR COMMUTER TRANSPORT (A COPERNICAN CHANGE)

SHIGENORI ANDO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, Aug. 1991, p. 432-435. In Japanese. refs

The use of airships for commuter transport is investigated. Three basic factors are discussed: the number of ground crew personnel, the airship scale, and advertising income. It is shown that the advertising income can exceed the transportation

expenditure of the small or medium size airship. This would encourage the development of airships for commuter transportation. Y.P.Q.

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GENERAL

A91-53932

SAENGER PROJECT IN THE SOVIET UNION [SAENGER-PROJEKT IN DER SOWJETUNION]

FERDINAND C. W. KAESMANN Luft- und Raumfahrt (ISSN 0173-6264), vol. 12, July-Aug. 1991, p. 50-53. In German. Copyright

Soviet applications of the ideas of German aerospace pioneer Saenger concerning very long range aircraft are examined based on recent disclosures from Soviet archives. Emphasis is given to a proposed variant of the Saenger-Bredt rocket glider designed by Keldysch. The most important data on this rocket glider are given. C.D.

A91-54063#

APPLICATIONS OF VSTOL AND STOVL TECHNOLOGY TO BATTLE GROUP CONCEPTS

DAVID L. GREEN (Starmark Corp., Arlington, VA) and W. T. R. BOGLE (U.S. Navy, Washington, DC) AIAA, AHS, and ASEE, Aircraft Design Systems and Operations Meeting, Baltimore, MD, Sept. 23-25, 1991. 16 p. refs (AIAA PAPER 91-3148) Copyright

A U.S. Navy study has established that future surface force operations independently of a conventional aircraft carrier will require an organic aviation component, and that the aviation missions entailed could be addressed by VTOL aircraft such as the V-22 tilting and STOVL aircraft such as the AV-8B, in conjunction with naval helicopters. The vessels from which these aircraft would operate could be similar to the Container Dock/Multimission ships recently proposed by the David Taylor Research Center. The missions considered by the study were of maritime surveillance and strike-support type, as defined in the framework of the Air Integrated Surface Warfare operations concept. O.C.

A91-56103

50 YEARS OF JET-POWERED FLIGHT - THE ROAD (LEADING) TO THE FIRST MASS-PRODUCED JET ENGINE JUNKERS JUMO 004 AND LATER GENERATIONS IN THE USA

ANSELM FRANZ IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 33-43. refs Copyright

The developments leading to the Jumo 004 are described. Particular attention is given to the development of the 004 engine and the Lycoming turbine. Emphasis is placed on the author's contributions to these projects. B.J.

A91-56222

COOLED, TRANSONIC TURBINE CASCADE TESTING

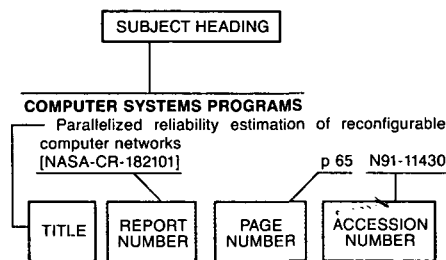
H. L. MOSES, J. A. SCHETZ (Virginia Polytechnic Institute and State University, Blacksburg), and B. A. GREGORY (GE Aircraft Engines, Cincinnati, OH) IN: International Symposium on Air Breathing Engines, 10th, Nottingham, England, Sept. 1-6, 1991, Proceedings. Vol. 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1991, p. 1130-1137. Copyright

A recently-developed facility for testing cascades of cooled, transonic turbine blades is described with experimental results.

The facility is a blowdown-type with run times of approximately 20 seconds. To simulate the proper density ratio in a cold-air facility, CO₂ is used as the coolant gas. In the present experiments, the cascade is made up of 11 blades with a span of 15.24 cm, an axial chord of 3.81 cm, and a spacing of 3.81 cm. The coolant is ejected on the pressure side near the trailing edge. To study the trailing edge region in more detail, a similar cascade has been constructed with 4 blades that have an axial chord of 12.42 cm. The experimental results presented are for a study of the effects of trailing edge thickness and coolant ejection on aerodynamic performance. For the geometry tested, the trailing edge thickness has a significant effect, but the effect of coolant ejection is small. A procedure for studying the effect of an unsteady, passing shock wave generated upstream of the blades is also described. Shadowgraph pictures show the shock at different positions in the blade passages.

Author

Typical Subject Index Listing



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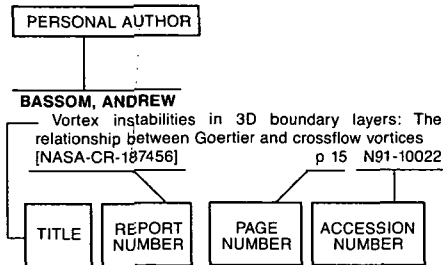
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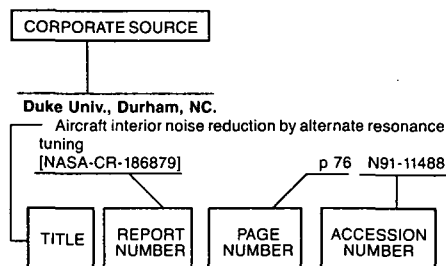
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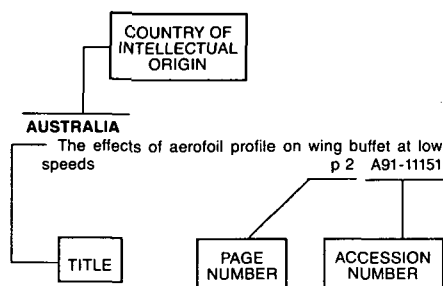
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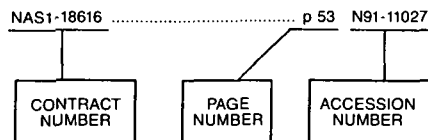
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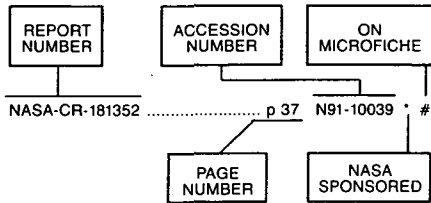
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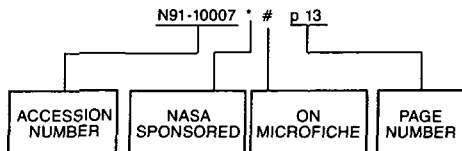
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